Publication 296

1984 FIELD CROP RECOMMENDATIONS

Ministry of Agriculture and Food
ONTARIO
Dennis Timbrell
Minister

POLICY STATEMENT

Pesticide products listed in this publication have been reviewed by the Ontario Pesticide Advisory Committee and have been classified under the Ontario Pesticide Act.

Space limitations in this publication restrict the amount of detail which can be included in each recommendation. Detailed recommendations are provided, by law, on the container label of commercial products. Read and follow the directions, conditions, and limitations described on such labels. This is the only way to make effective, safe use of such products. See also General Information on Pesticide Usage section.

Additional information can be obtained from the local office of the Ontario Ministry of Agriculture and Food. See General Information section.

All pesticide products are registered by Agriculture Canada. No pesticide may be used on any crop for which it is not registered. Such use can result in seizure of the crop. Pesticides not listed alphabetically are in order of preferance.

EMERGENCY PROCEDURES FOR PESTICIDE POISONING

If a person suspects poisoning from exposure to a pesticide by swallowing, inhalation, or contact with skin or eyes, read the label on the pesticide container and carry out the first-aid treatment suggested.

If a pesticide has come in contact with the skin or has been spilled on clothing, remove the clothing and wash the skin thoroughly with soap and warm water.

If a pesticide has come in contact with the eyes, rinse them with plenty of water for 15 minutes.

IMMEDIATELY AFTER THE FIRST-AID TREATMENT HAS BEEN GIVEN, WRAP THE PATIENT IN A COAT OR BLANKET AND RUSH HIM TO THE NEAREST HOSPITAL. TAKE WITH YOU THE COMMON NAME AND BRAND NAME OF THE CHEMICAL ALONG WITH THE MANUFACTURER'S NAME.

FIRST-AID TREATMENT

The Occupational Health and Safety Division, Ministry of Labour, 400 University Ave., Toronto, M7A 1T7, has physicians available for consultation on first-aid information and advice. They can be contacted in the following manner:

Between the hours of 8:00 a.m. and 5:00 p.m. Monday to Friday, telephone (416) 965-3610.

During weekends, public holidays and non-office hours telephone (416) 965-1211 and ask for the "on-call" physician.

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CROP MANAGEMENT

Seeding Date and Planting Depth Optimum seeding date centers on May 7 in southwestern Ontario, and May 10 in central and eastern Ontario. Those seeding earlier commonly must contend with lower soil and air temperatures. Studies show there is a relationship between emergence, temperature, and depth of seeding. Early seedings should be sown shallow (3 to 5 cm at a maximum). If they are sown deeper, a delay and reduction in emergence can occur. The result is an uneven stand. For later seedings (temperature is warmer) there may be a slight slowing of emergence for deeper plantings but the reduction in stand likely will be small.

Seed Size All seed sold for plate-type planters is sized in three dimensions; length, width and thickness. Although there are a large number of different seed sizes for any one hybrid, all bags of seed sold have a recommended seed plate for the specific size of seed in the bag for most common makes of plate planters. With plate planters, the desirable situation is to have one seed in each cell of the plate with no misses, no doubles and no split seed. However, one way to check that you are getting the desired plant stands is to calibrate your planter on a hard surface at field speed. With plateless planters, manufacturers' instructions should be followed to insure accurate seeding rates with all seed sizes. All seed sizes within a hybrid are identical in terms of genetic potential. There is no evidence that large seeds of one hybrid will produce larger plants and thus more yield than smaller seeds of the same hybrid.

Plant Populations A final plant population of 50,000 to 62,000 plants per hectare is recommended, irrespective of the row width used. However, on making a final decision on what plant populations to aim for, several additional factors should be considered.

1. The final plant stand should be 50,000 plants per hectare where the yield levels have tended to be low and plant lodging is a problem. On soils that are low in fertility, susceptible to drought, or imperfectly drained, the lower populations are well worth considering. The population should also be lowered under late planting conditions.

2. Consideration should be given to increasing plant density up to 62,000 plants per hectare on farms with a history of high yields and low plant lodging. On fertile, well-drained soils with high moisture-holding capacity, an increased plant density is most likely to return dividends. Higher plant populations are more often warranted in the shorter season areas (less than 2900 heat units), and under conditions where corn is planted early.

3. Consideration may be given to increasing plant populations in corn that is being produced for whole plant silage to between 62,000 and 70,000 plants per hectare. These higher populations have given highest yields in Ontario research trials, with no effect on grain content or dry matter percentage of the silage. Populations above 62,000 plants per hectare should not be used on droughty soils, when the crop might be harvested for grain, or in regions with 3100 or more heat units. Increased populations will lead to greater stalk breakage for corn that is being produced for grain. This will not occur in corn harvested for whole plant silage because corn silage is harvested at an earlier stage of growth.

The reason for increasing plant density is to try and realize a higher harvested yield per acre. However, as the plant density is increased, the plants are under greater stress since there are more plants competing for the moisture, fertility and light available. With denser plant stands any additional stress such as drought, low fertility, weed competition, insects or diseases will have a more detrimental effect on grain yield, grain quality and lodging. It is quite probable that slight increases in grain yield could be lost at harvest-time due to increased harvesting losses resulting from smaller ears and more lodging.

Table I gives the distance between seeds required to achieve a specified population.

Table I. Centimetres Between Seeds to Achieve Specific Populations

Final Plants/ hectare[1]	Seeds Per hectare[2]	Row Width - centimetres[3]						
		71	76	81	86	91	97	102
40,000	43,900	32	30	28	26	25	23	22
45,000	50,000	28	26	25	23	22	21	20
50,000	55,600	25	24	22	21	20	19	18
55,000	61,100	23	22	20	19	18	17	16
60,000	66,700	21	20	19	17	16	15	15
65,000	72,200	20	18	17	16	15	14	14
70,000	77,800	18	17	16	15	14	13	13

1 *1 hectare = 2.47 acres*

2 *Based on 10% loss of plants. With planting after the optimum planting date, a loss of 5% of the plants may be more realistic.*

3 *1 centimetre = 0.39 inches*

HYBRID SELECTION

1984 Recommended Hybrids Corn hybrids suitable to Ontario conditions are listed in the *1984 Ontario Hybrid Corn Performance Trial Report.* Growers are strongly advised to consult this report for information on the performance of recommended hybrids for their specific heat unit area.

Choosing Hybrids For Your Farm By Heat Units Locate the vicinity of your farm in Figure I and estimate the heat unit rating for your farm. If you plant corn BEFORE mid-May, choose a hybrid from among those on the recommended list having EQUAL or LOWER rating than your farm.

If soil conditions or any other factor on your farm usually DELAY planting later than mid-May, then for a DELAY of one week or more, DEDUCT 100 heat units for EACH week from the rating for your farm and select hybrids from the list having that rating, or a LOWER rating.

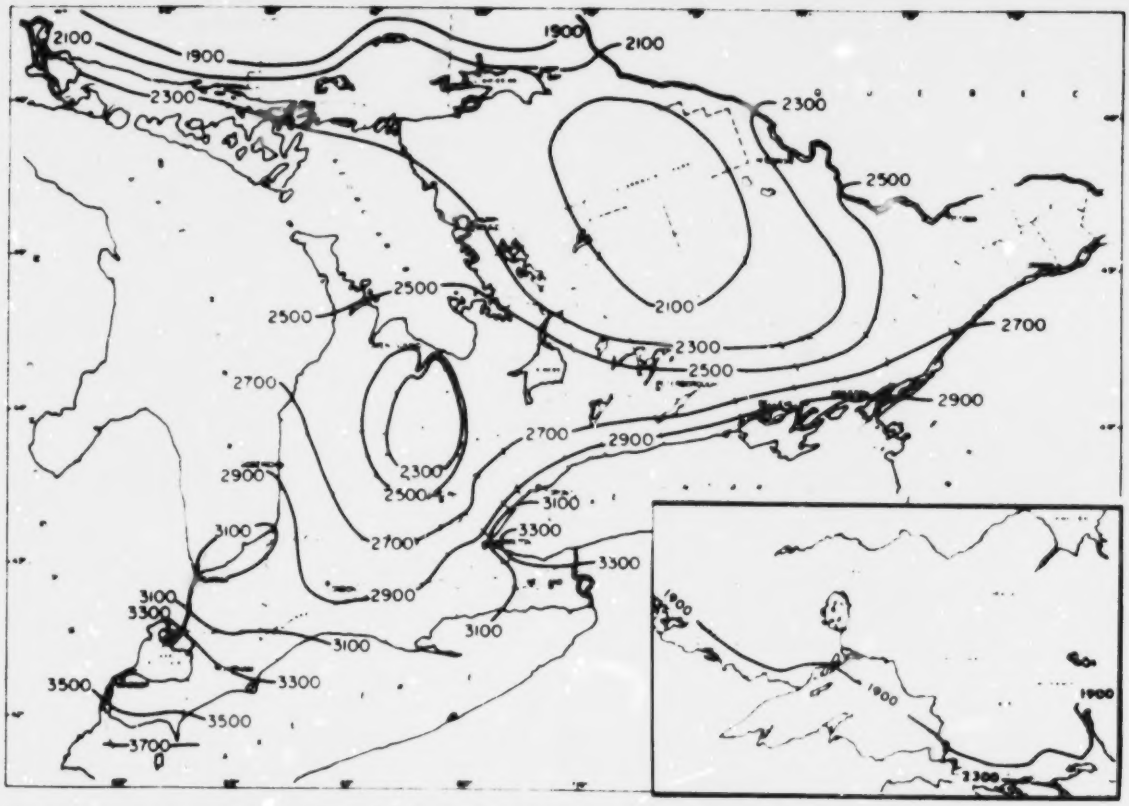
Research and experience have demonstrated that hybrids producing high grain yields also produce high silage yields.

FERTILIZERS FOR CORN

Fertilizer requirements for corn in Ontario can best be estimated by using a soil test along with information on past management. Fertilizer recommendations are based on the results of trials run on research stations and farm fields in Ontario. The recommendations in this publication can be expected to produce the highest economic returns from the crop when good or above average management is used.

To provide dependable fertilizer recommendations each field should be tested at least once every third year. When large amounts of nutrients are removed from sandy soils (e.g. with crops such as hay, corn silage, potatoes, tomatoes), annual testing is advisable as potash soil tests can change rapidly under those conditions.

FIGURE 1. Heat Units Available for Corn Production



Where a soil test is not available a rough estimate of fertilizer requirements can be obtained from the accompanying table using the following guidelines:

a. Where the field has been fertilized regularly for a number of years or heavily in recent years, use one of the rates of phosphate and potash recommended for the MEDIUM soil test rating (see Table 4);

b. If the field has received little fertilizer in the past, use one of the rates recommended for LOW soil test rating (see Table 4). Some clay and clay loam soils are naturally high in potassium and do not require any potash fertilizer. Only a soil test can adequately determine potash requirements.

Nitrogen

No soil test is available which is satisfactory for nitrogen under Ontario conditions. Nitrogen fertilizer recommendations for corn are, therefore, based on the region of the province and the expected yield and adjusted downward if manure is applied or if the previous crop contains perennial legumes such as alfalfa.

Nitrogen (N) Recommended for Corn for Southwestern Ontario

The most profitable rate of nitrogen application is affected by the price of corn and the price of nitrogen. Table 2 shows the relationship for the Counties of Essex, Kent and Lambton and for the clay and clay loam soils of Huron, Perth, Middlesex and Elgin.

Table 2. Relation of Corn and Nitrogen Prices to the Most Profitable Sidedressed Nitrogen Applications for Southwestern Ontario[1]

(The Counties of Essex, Kent and Lambton and clay and clay loam soils in Elgin, Huron, Middlesex and Perth)

Price Ratio corn $/t / N $/kg	Expected Yield[2] grain — t/ha				
	6	7	8	9	10
	Most profitable nitrogen application kg N/ha[3]				
100	75	80	90	95	105
200	115	125	140	150	160
300	135	150	165	185	200
400	145	160	180	200	220

[1] 100 kg/ha = 90 lb/ac.
To use the table, the price of corn must be known or estimated. Corn at $150/t and nitrogen at $0.50/kg results in a price ratio of 300. At these prices and an expected yield of 7t/ha you should use 150 kg N/ha.

[2] *Expected yield is that yield which from experience you expect from your soil, climate and management. One tonne grain yield is equivalent to 5 t silage.*

[3] *Nitrogen rates presented are for sidedress application. For preplant application an additional 30 kg N/ha should be applied. Nitrogen rates should be adjusted downward if the preceding crop was a legume sod (See Nitrogen Adjustment for Legumes Plowed Down section), or if manure is applied (See Manure in Soils section).*

Table 3. Nitrogen (N) Recommended for Corn for Eastern and Central Ontario and sandy loam, loam and silt loam soils in Elgin, Huron, Middlesex and Perth Counties[1]

Expected Yield[1]		
Shelled Corn	Silage Corn	Nitrogen (N)[2] Required
t/ha[3]	t/ha	kg/ha[3]
5	25	80
6	30	100
7	35	120
8	40	140
9	45	160

[1] *Expected yield is that yield which your experience indicates you should obtain under your conditions of soil, climate and management.*

[2] *Nitrogen rates should be adjusted downward if the preceding crop was a legume sod (see Nitrogen Adjustment for Legumes Plowed Down section) or if manure is applied (see Manure in Soils section).*

[3] *1 t/ha = 0.45 ton/ac = 16 bu/acre 100 kg/ha = 90 lb/ac*

Phosphate and Potash

Phosphate and potash requirements for corn are presented in Table 4. These recommendations are based on soil tests conducted in the Ontario Ministry of Agriculture and Food (OMAF) soil testing laboratory at the Department of Land Resource Science, University of Guelph. These tables should not be used with soil test readings from other soil testing laboratories unless the methods used are identical to those used in the OMAF laboratory.

Table 4. Phosphate and Potash Requirements for Corn Based on OMAF Soil Tests

Soil test	Rating	Phosphate (P_2O_5)[1] required—kg/ha	Soil test	Rating	Potash (K_2O)[1] required—kg/ha
0 - 3	LOW	110	0 - 15	LOW	170
4 - 5		100	16 - 30		160
6 - 7		90	31 - 45		140
8 - 9		70	46 - 60		110
10 - 12	MEDIUM	50	61 - 80	MEDIUM	80
13 - 15		20	81 - 100		50
16 - 20		20	101 - 120		30
21 - 30	HIGH	0	121 - 150	HIGH	0
31 - 60	VERY HIGH	0	151 - 250	VERY HIGH	0
61+	EXCESSIVE[2]	0	251+	EXCESSIVE[2]	0

100 kg/ha = 90 lb/ac.

1 *Where manure is applied reduce the fertilizer application according to the amount and quality of manure (see Manure in Soils section) Example of fertilizer application: If the expected yield of corn grain in a particular field in Oxford County is 7 t/ha, the nitrogen recommendation would be 120 kg/ha (see Table 3). If the soil tests are 11 for phosphorus and 110 for potassium, the phosphate requirement is 50 kg/ha and the potash requirement 30 kg/ha (from above table). The phosphate can be supplied by 160 kg/ha (50 ÷ 32 x 100) of 8-32-16 applied 5 cm to the side and 5 cm below the seed at planting. It would supply 12 kg nitrogen and 25 kg potash/ha. The remaining 108 kg N/ha can be supplied with 130 kg (108 ÷ 82 x 100) kg of 82-0-0.*

2 *For a nutrient which has an excessive rating by soil analysis, the application of this nutrient in fertilizer or manure may cause problems due to reduced crop yield or quality. Phosphorus additions may induce zinc deficiency on soils low in zinc and increase the risk of water pollution. Potash additions may induce magnesium deficiency on soils low in magnesium.*

Micronutrients and Magnesium

Although magnesium is plentiful in most soils in Ontario, magnesium deficiency does occur on acid, sandy soils. The symptoms appear first as yellow striping of the lower leaves. As the deficiency worsens, the upper leaves may become striped while the lower leaves turn reddish-purple.

All soil samples analysed under the OMAF soil testing program are tested for magnesium. This test is a reliable guide for determining magnesium requirements.

Dolomitic lime is an excellent source of magnesium. Where limestone is required to correct soil acidity, dolomitic lime should be used whenever the magnesium test is under 100.

Few soils that do not need lime will require magnesium. Magnesium application is recommended only if the magnesium test is under 20. On these soils, magnesium can be supplied either by magnesium sulphate or, if potassium is also required, by sulfate of potash magnesia.

Over-application of potassium can induce magnesium deficiency. For this reason it is important to monitor soil potassium levels closely, and restrict potash application rates to those recommended by the OMAF soil test.

Zinc deficiency occurs on corn in Ontario. Visual symptoms on the leaves are the best means of determining deficiency but soil tests are also useful. Response to zinc should not be expected unless deficiency symptoms are quite marked.

When zinc is required it may be applied to the soil mixed in the fertilizer at rates supplying 4 to 14 kg zinc/ha. The higher rate should be sufficient for up to 3 years. Not more than 4 kg zinc/ha should be banded at planting. Zinc may be applied as a foliar spray at rates supplying 60 g zinc/100 litres (0.6 lb/100 gal). A wetting agent should be added. Spray to leaf wetness.

Other micronutrients are not likely to be deficient on corn in Ontario.

Methods of Application

Nitrogen should be applied in the spring with the major portion either as a preplant application or side-dressed before the corn is 30 cm high. Fall application of nitrogen is not recommended. In Essex, Kent and Lambton Counties and on the clay and clay loam soils of Huron, Perth, Middlesex, and Elgin, preplant applications of nitrogen have not been as efficient as side-dressed applications. For preplant application an additional 30 kg N/ha should be applied. On these soils in this area anhydrous ammonia has produced 3-5% higher yields than ammonium nitrate or urea. In the remainder of Ontario, preplant application is equal to side-dress application.

Solid forms of nitrogen or 28 to 32% solutions may be applied to the surface of the soil without incorporation. Under dry conditions the effectiveness of all forms of nitrogen fertilizer may be improved by incorporation. If the fertilizer solutions contact leaves, burning and yield reductions are likely to occur.

Anhydrous ammonia, applied with conventional equipment, should be placed a minimum of 15 cm deep in the soil. When appropriate equipment is used, ammonia may be applied with a cultivator or disc a minimum of 10 cm deep with the ammonia outlets spaced no more than 45 cm apart. Because anhydrous ammonia may damage plants, it is preferable to make a pre-plant application crossways to the direction the corn will be planted.

The major portion of the phosphorus and potassium may be broadcast and plowed or worked into the soil either in the fall or spring. However, where soil tests show a requirement for these nutrients a fertilizer containing nitrogen and phosphorus or nitrogen, phosphorus and potassium should be applied as a starter at planting time. The starter fertilizer should be applied in one of two ways:

1. In a band 5 cm to the side and 5 cm below the seed. The rate of application in the side band should not supply more than 55 kg of nitrogen per hectare or a total of 90 kg of nitrogen plus potash (K_2O) per hectare in one metre rows. If urea is the nitrogen source, not more than 30 kg of nitrogen or 60 kg of nitrogen plus potash per hectare in one metre rows.

2. In a band directly with the seed. With this placement not more than 7 kg nitrogen plus potash (K_2O) per hectare should be applied in one metre rows. Neither urea nor diammonium phosphate should be applied with the seed.

To Calculate Nitrogen and Potash Content

100 kilograms 6-24-24 per hectare provides 6 kg nitrogen and 24 kg potash for a total of 30 kg.

200 kg 8-32-16 provides 16 kg nitrogen and 32 kg potash for a total of 48 kg.

DISEASE AND INSECT CONTROL IN CORN
(see also Pesticides section)

Seed Treatment

Follow the precautions under Seed Treatments in General Information on Pesticide Usage section, when applying chemical seed treatments.

Seed corn sold in Ontario has been treated with a fungicide, such as captan, Vitaflo 280 or thiram, for protection against **seed decay** organisms. A treatment may also have been applied to control insects that attack seed in storage. Additional treatments to protect seeds from soil-inhabiting insects should be applied every year. Use diazinon to reduce damage by **seed maggots** and lindane for protection from **wireworms.** Seed treatment combinations of diazinon and lindane are available from seed suppliers and should be applied as recommended. Follow the directions on the label with care. Thorough mixing is important.

Apply insecticides to the seed just before planting or mix them with the seed in the planter box. Use a wooden paddle to mix the chemicals and seed.

DISEASES

General Preventive Measures

1. Plant hybrids resistant to leaf blights and stalk rot (see below and check with seed company).

2. Plow under old cornstalks and leaves to help kill overwintering disease fungi.

3. Rotate corn with other crops to help prevent disease buildup.

4. Minimize plant stress by:

    a. Avoiding plant populations that are too high for the hybrid grown.
    b. Maintaining high soil fertility, good soil structure, and good drainage.

Leaf blights Northern leaf blight and leaf spot sometimes appear especially on lower leaves. Both diseases are favored by moderate temperatures, long dew periods, and rain. Most recommended hybrids have good resistance.
See OMAF Factsheet, *Leaf Diseases of Field Corn*, Agdex 111/632.

Eyespot is usually severe only in wet seasons in fields with much corn debris from the previous season or on highly susceptible hybrids. Crop rotation and clean plowing of corn debris helps to reduce disease severity.

Anthracnose has been found on corn in southern Ontario during the past three years. The disease may affect both leaves and stalks. Rotation of corn with other crops and plowing down corn residues cleanly will reduce disease severity. See OMAF Factsheet, *Leaf Diseases of Field Corn*, Agdex 111/632.

Stalk Rot Grow hybrids with low stalk breakage counts, as listed in the current *Ontario Hybrid Corn Performance Trials.* Copies are available from your county office of the Ministry of Agriculture and Food. Stalk rot is often serious in fields with high plant

populations, low fertility, and poor soil conditions. Harvest as early as possible because stalk rot develops mostly on mature plants and becomes a greater problem the longer the crop is left in the field.

Ear Rot Pink, white, green and black molds may develop on ears. The pink molds, and less often the white molds, may produce toxins, including estrogens and vomitoxin, which have serious effects on livestock, especially pigs and poultry. The green and black molds do not normally pose a problem except when, in great abundance, they may put livestock off feed. Development of the ear rot is stopped when corn is dried, or ensiled, but the level of harmful toxins, if present, remains unchanged. Where corn is stored in cribs these fungi will, under favorable weather conditions, continue to grow and produce toxin until corn moisture drops below 20%. See OMAF Factsheet, *Moldy Feeds and Swine Diseases*, Agdex 440/60.

Storage and Feeding Precautions

1. Exercise caution in feeding moldy corn, especially to hogs. Pink or reddish molds are particularly harmful.

2. For assistance with problems of moldy feeds, contact the county office of the Ontario Ministry of Agriculture and Food. It may be recommended that the feedstuff be analyzed for toxins.

3. Avoid cribbing corn with pink ear rot.

Head Smut This disease was first observed in Ontario in 1979. Incidence of head smut in field corn has been low since 1980. However, spores of the head smut fungus survive in the soil for several years. This disease is easily confused with common smut but is much more destructive. Recommended hybrids differ in degree of resistance to head smut. Consult OMAF Factsheet, *Head Smut of Corn*, Agdex 111/632 for further details of the disease.

On farms where head smut has not been identified, there is no need to select hybrids on the basis of head smut resistance. Select hybrids based on characteristics such as yield, stalk strength, maturity, etc.

On farms where head smut has been identified, selection of hybrids with resistance should be considered. However, be sure to also consult the current *Ontario Hybrid Corn Performance Report* for information on yield, stalk strength and maturity of these hybrids. Information on hybrids with resistance to head smut is available from your County office of the Ministry of Agriculture and Food.

INSECTS

Corn Rootworms There are two species of corn rootworms that damage corn in Ontario. The northern corn rootworm is still the predominant species east of Toronto, while the western corn rootworm is the predominant species west of Toronto.

The larval stages of these species feed on corn, causing damage by tunneling through and pruning roots from mid June to mid July. When fully grown the slender, white larvae are about 1.5 cm long. The northern adult is a plain yellow or green beetle about 0.5 cm in length; the western adult is yellow with black markings and is slightly larger than the northern adult. Both adults feed on corn silks from August to the first frost. See OMAF Factsheet, *Corn Rootworms*, Agdex 111/622.

Crop rotation is recommended to control both species of rootworms. If crop rotation is not practical and extensive goosenecking occurs throughout a field, then check roots for evidence of rootworm feeding. When feeding is evident apply a soil insecticide at planting the following spring. Use a planter-mounted granular insecticide applicator with a spreader attachment to place an insecticide in at least a 15-cm band in front of the press wheel but not in contact with the seed. A spring-tooth attachment or a drag chain

mounted behind the press wheels is recommended on Max-Emerge™ planters. Calibrate the applicator each year and when switching chemicals or changing planting speed. Do not use a broadcast application. To avoid wind drift and poor control, mount the spreaders as close to the ground as possible. Any one of the following insecticides may be used. Consult the insecticide label for manufacturer's directions for use.

Table 5. Corn Rootworm Control

Insecticide[1] Applied in a 15-cm band	Rate of Product[2] Grams per 100 m of row Any Row Width	kg/ha at Row Width of 90 cm	75 cm
Amaze 20 G[3]	55	6.2	7.2
Birlane 10 G	110	12.2	14.6
Counter 15 G[4]	75	8.3	10.0
Dasanit 15 G	75	8.3	10.0
Di-Syston 15 G	75	8.3	10.0
720 LC[5]	15 mL	1.66 L/ha	2 L/ha
Dyfonate 20 G	45 - 55	4.7 - 6.1	5.7 - 7.3
Furadan 10 G	110	12.2	14.6
Lorsban 15 G[6]	75	8.3	10.0
Thimet 15 G	75	8.3	10.0

G (Granular); LC (Liquid Concentrate).

1 ***CAUTION:*** *Do not use the same insecticide two years in succession, otherwise the development of insect resistance may be promoted. All of these insecticides are extremely poisonous to the operator. Handle with care. Follow all safety precautions on the label. Only purchase what is needed for one year. Store under lock and key and not with food or animal feed. For additional information see Pesticides section.*

2 *Use higher rate on clay soil or soil high in organic matter, and in fields with a history of severe rootworm.*

3 *Do not use on muck soils.*

4 *Also controls seed corn maggot and wireworms.*

5 *Liquid concentrate must be sprayed in a 15-cm band for control. Do not apply with liquid starter fertilizer because the band is not wide enough for control of rootworms.*

6 *Placement behind the planter shoe and ahead of the press wheel is particularly important.*

European Corn Borer The stalk breakage problem in any year cannot be predicted but will depend on many factors including weather conditions, stalk rot, wind and borers.

The cream-colored female moth usually lays her eggs on the underside of corn leaves, beginning in early June in southwestern Ontario and somewhat later in other parts of the province. After hatching, the young borers feed on the leaves, giving them a pin-pricked appearance. Sometimes the feeding scars are elongate. Later, the borers work downward into the "throat" (whorl) of the plant and feed on the developing leaves. Afterwards, they enter the stalk. Control is effective only if the borers are destroyed before they enter the stalk. It is most important to select a hybrid with good standability and

thus some resistance to breakage. Avoid plant populations that are too high for the hybrid grown. Higher plant populations lower stalk quality and can result in more breakage. In addition, growers should plant as early as feasible to reduce the infestations by the second generation where it occurs, and to obtain as early a harvest as possible. Harvest as soon as suitable moisture levels are reached to decrease losses from dropped ears and broken stalks which occur during autumn storms.

European Corn Borer Strains There are two distinct strains of the European corn borer in Ontario. Most areas have the strain with a single generation per year, but south of a line from Sarnia to London and Simcoe, the strain has two generations per year. There is some resistance to leaf feeding by the single-generation strain and the first generation of the two-generation strain, but none by the second generation feeding where it occurs. The resistance ratings, as such, are not available but are reflected, among other factors, in the standability ratings available in the current *Ontario Hybrid Corn Performance Trial Report*.

Two-Generation Area In the southwestern area where the two-generation strain occurs, the second generation is larger than the first, is more abundant in late-planted corn, and is responsible for most of the ear loss due to damaged shanks and stalks. For this reason the non-chemical recommendations listed above are generally preferable. If insecticides are applied, use a material listed below but apply it in August agcinst the second generation. Eggs for this generation are laid over a five-week period and eggs can be laid in any one field over a three-week period. Probably more than one application would be required for significant control.

One-Generation Area Where only one generation occurs, losses can be high enough to warrant control. You should examine the plants for borer feeding before tassels show in the whorl or when plants are about 60 cm tall. Examine the plants at 10-day intervals and spray if you find that more than 50% of the plants have feeding scars. Two applications, 7 to 10 days apart, may be needed for significant control. Once the larvae bore into the stalks, treatments are not effective and should not be applied. In some years the one generation strain produces a partial second generation. This flight is usually small and occurs towards the end of August. It does not pose a serious threat to corn. For further information, see OMAF Factsheet, *European Corn Borer*, Agdex 111/622.

Table 6. European Corn Borer Control

Insecticide	Formulation[1]	Product per ha
+Furadan	480 F	1.1 L
Sevin XLR[2]	480 Su	2.5 - 4.0 L

1 *F (Flowable); Su (Suspension)*

2 *Several formulations of Sevin are available for use according to label instructions. Sevin XLR is recommended because it is less hazardous to bees. Follow precautions applying to honeybees. See Protect Honeybees section.*

\+ *Minimum period before re-entry is 48 hours. See Reentry into Treated Areas.*

Bees often visit sweet and field corn to collect pollen. Where spraying is being done bee poisoning may result. **Sevin and Furadan are highly toxic to bees** but Sevin is the most damaging since it is carried to the hive and poisons the brood. If bees are in the area, advise local beekeepers of spraying activity and do not use Sevin. Your local agricultural representative has a listing of beekeepers in your area. Damage to bees is reduced when sprays are applied in early morning or late evening when bees are not foraging. Do not treat when the wind is blowing. Avoid contamination of roadsides and adjacent fields where plants may be in bloom.

Cutworms They are found in the soil and attack seedling corn in the two- to five-leaf stage. Plants suddenly wilt because the stem is hollowed out or cut off at or just below ground level. The cutworms can usually be found in the soil within a few centimetres of damaged plants. There are a number of species of cutworms and they may be gray to dark brown in color and striped or mottled. Mature cutworms are about 3.5 cm long. Cutworms that are nearly mature (over 2.5 cm long) are difficult to control but they will stop feeding in a few days when they reach full size. It is not recommended to apply insecticide in this case because most of the damage is done and it is better to wait a few days and replant. Treatment is most effective when applied soon after cutworms have hatched. Only a small acreage of Ontario corn has cutworm problems any one year. For this reason, and because corrective sprays are available, granular treatments applied at planting time are not recommended.

If seedling corn is attacked and the cutworms are small, apply one of the following treatments in 400 L of water per hectare at the seedling (2- to 5-leaf) stage when damage first appears. Cutworms are most active in the evening and treatments are best applied at this time.

Table 7. Cutworm Control[2]

Insecticide	Formulation[1]	Product/ha
Ambush[3]	500 EC	225 - 300 mL
Lorsban	4 C	2.8 L

1 *C (Concentrate); EC (Emulsifiable Concentrate)*
2 *Seedling stage only.*
3 *Read the label. Do not disturb the soil for 5 days after application.*

Armyworm Because grassy and weedy corn is attractive to armyworm moths for egg-laying, eliminate grasses and weeds from the corn crop. The result will be less armyworm damage to corn (see Ontario Ministry of Agriculture and Food Publication 75, *Guide to Chemical Weed Control*). When armyworms move into corn fields, spray the border rows and adjacent cereals, pasture, or hay crops. Refer to Armyworms in Cereals section for more information.

Potato Stem Borer This pest of corn is more severe in the eastern counties of Prescott, Glengarry, Russell, Stormont, Carleton, Dundas and Renfrew, but infestations have been found throughout Ontario.

Seedling corn is destroyed by larvae (pinkish worms 4 cm long when mature) that bore into the base of plants just below or above ground level. The leaves of infested plants

wilt and turn brown from the tips downward. Seedlings up to 40 cm high wither and die. Such plants break off at ground level when pulled. The worm may be found in the stalk or in the soil near the base of the plant. The larvae move to corn in late May or early June from grassy field borders.

At present there are no effective insecticides to control the potato stem borer in the corn. To reduce potato stem borer infestations, maintain weed-free fields and borders by plowing, cultivation and with the use of herbicides as outlined in OMAF Publication 75, *Guide to Chemical Weed Control.*

The primary weed hosts are perennial grasses and these must be killed in the fall or early enough in the spring to prevent the survival of borers. Herbicide treatments later than May 1st will probably do more harm than good. Evidence suggests that such treatments fail to kill borers but cause them to move to corn sooner. Where the potato stem borer has been troublesome in the past, doubling the plant stand by over-planting the border rows can help by compensating for seedling mortality.

Corn Leaf Aphid These small dark aphids do not overwinter in Ontario. Each year they are carried into the province by air currents. Populations of 400 or more per plant, especially under dry conditions, may be economically important. See OMAF Factsheet, *Corn Leaf Aphid*, Agdex 111/622.

White Grubs The larvae of June beetles have plump, white bodies with large brown heads and six prominent legs. They are found in a "C"-shaped position in the soil near the roots of plants. The adults lay their eggs in sod and white grubs are therefore a problem in corn following sod, particularly in run-down fields or pastures. When such fields are plowed, the partly grown larvae can be found, especially if the sod is broken apart and examined carefully.

To avoid damage, do not plant corn following grass sod.

Sap Beetles They are small dark beetles about 6 mm long with two yellow spots on each wing cover. These beetles are often numerous in corn fields but do not cause significant damage. For more information see Ontario Ministry of Agriculture and Food Factsheet, *Sap Beetles on Raspberries, Tomatoes and Corn*, Agdex 675.

INSECTS IN STORED GRAIN

Stored Grain Insects - Surveys have shown that stored grain in county elevators and on farms in Ontario have the heaviest insect infestations of any region in Canada. **This situation must be corrected.** See section INSECTS IN FARM STORED GRAIN under Cereal Crops, Insect Section.

WEED CONTROL IN CORN

For weed control recommendations see OMAF Publication 75, *1984 Guide to Chemical Weed Control.*

CROP MANAGEMENT

The production of perennial forage crops offers the Ontario farmer an opportunity to produce a substantial portion of his livestock's protein and energy requirements. In order to accomplish this, his perennial forage crops must be managed to the same degree as other high producing crops grown on the farm. This incorporates all aspects of forage production: variety selection; meeting fertility requirements; proper cutting schedules; weed, disease and insect control.

Choosing a Seed Mixture Success with a seed mixture depends upon the correct selection of the legume and the grass components to suit conditions under which the mixture will be grown. Simple mixtures containing one legume and one or two grasses are recommended as they are more productive than complex ones. Pure sowings of a legume or a grass are recommended under special conditions.

Selection begins with the choice of a legume to suit the intended use, soil drainage conditions, and the duration of stand desired. The suitability of each legume can be determined by reading the information provided about mixtures based on each legume. Once the legume base has been established the specific mixture and the varieties for use in the mixture can be chosen from the recommendations under Alfafa, Trefoil, White and Red Clover. Grass species and varieties for use in mixtures with legumes or as pure stands of grass are described under grasses. Legumes should be inoculated with the proper strain of viable inoculant.

The species and varieties of grass for use in mixtures with legumes for stored feed should be chosen on the basis of their maturity. The grass should reach early heading when the legume is ready to harvest, at first flower. Reducing the seeding rate of the grass fraction below that recommended may be advantageous on those farms where high protein feeds are required and grasses frequently predominate in mixtures.

Direct Seeding New forage seedings can be made without a companion crop. A direct seeding is recommended when establishing bird's-foot trefoil, and on those problem fields where forage stands are difficult to obtain. One or two harvests may be available from a direct alfalfa seeding in the seedling year prior to late August, yielding about 50 to 60% of the first production year.

Adequate plant nutrients, especially phosphorus, are essential for good forage seedling development. A band seeder attachment on a grain drill places the forage seeds directly over the fertilizer. Band seeding over a fertilizer containing phosphate aids seedling growth where direct seedings are made without a companion crop and on fields where thick vigorous stands are difficult to obtain (see also Fertilizers for Forage Crops).

Coated Seed Coated legume seed usually has one-third fewer seeds per kilogram than the same weight of non-coated or bare seed. Generally coated grass seed has 50% fewer seeds per kilogram. Research has shown that at recommended seeding rates there is no yield difference between equal product weights of bare seed and coated seed. However, with bare seed and early seeding on a fine firm seedbed, recommended seeding rates can be reduced by 25%. Limited research indicates that with coated seed, seeding rates should not be reduced below those listed in the tables.

Coated legume seed is a good system of inoculation. Carry over seed should be reinoculated prior to planting. Coated seed reduces seed treatment dust and some of the hazard associated with handling pesticides.

Some grass species have light seeds and coating aids in controlling flow and distribution at planting time particularly with aerial or broadcast seeding.

Coated seed has advantages, particularly with trefoil, in roughland pasture renovation and/or under adverse establishment conditions.

Coated seed is generally less expensive than bare seed for equal weights of product. However, under normal establishment conditions, growers may find reduced rates of non-coated seed to be more economical.

Harvesting Schedule All forages, and alfalfa in particular, are excellent sources of protein for ruminant livestock.

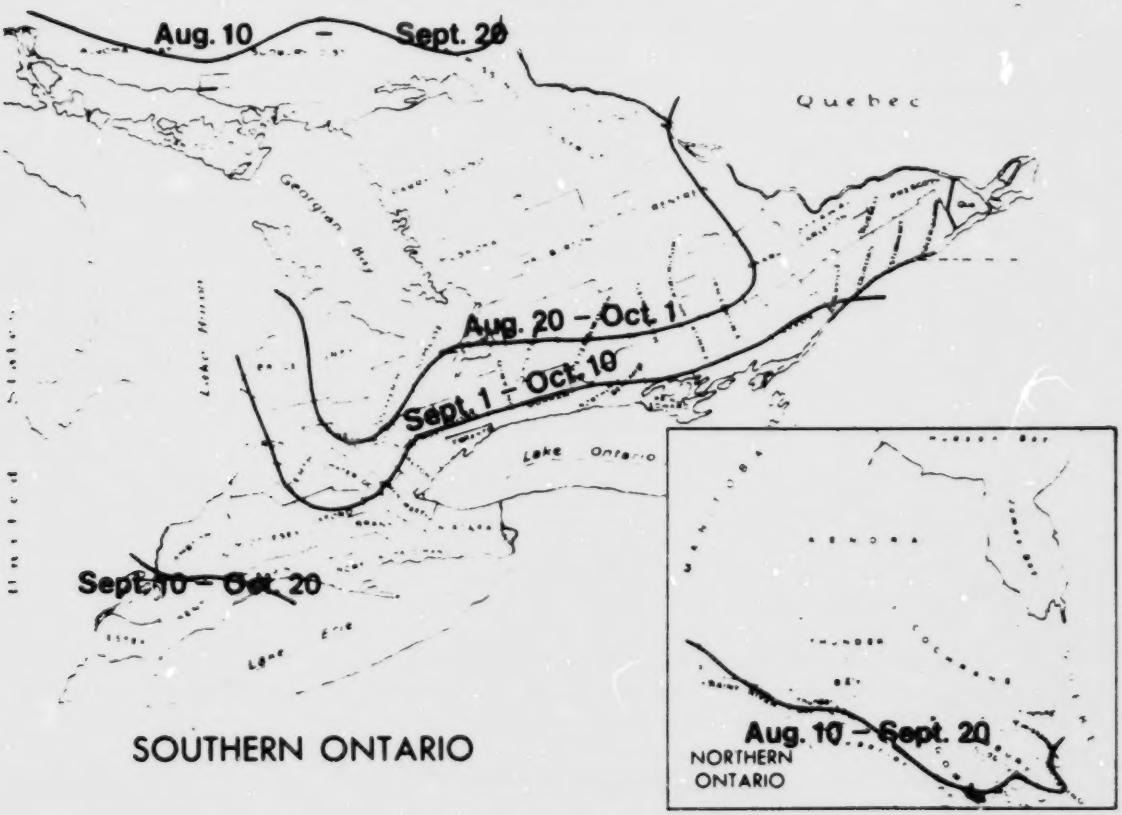
Feeding trials have demonstrated that forage legumes can supply most if not all of the protein requirements of high producing dairy cows; that faster and more efficient gains are obtained in young beef cattle (400 to 650 lb) when protein from forage rather than inorganic nitrogen is fed. When fed as a supplement, high quality forage legumes do not dilute the energy content of most cattle rations. In addition, protein from this source is low in cost.

In order to supply a concentrated high protein supplement, early cutting and careful handling to reduce leaf loss are essential. Harvesting as soon as the flower buds appear will result in a concentration of from 19 to 23% protein in the forage from alfalfa, bird's-foot trefoil or red clover. Where top production of high quality stored feed is planned, a haylage system works best. Three harvests at an early bud stage of legume development are necessary. The first crop must be harvested by the first week in June.

Since grasses contain about half as much protein as the legumes, their inclusion in mixtures will markedly decrease the protein content of stored forages. For example, alfalfa at the first sign of a flower will contain about 18% crude protein. Cut at the same stage but in a mixture with 50% timothy, the protein content of the feed would only be about 14%.

Retention of leaves is important as they contain approximately 70% of the protein in the crop. Leaf loss in harvesting, therefore, must be kept low. The use of mower

Figure 2. Critical Fall Harvest Dates for Alfalfa



conditioners, windrowing at cutting time or when the forage is tough, and/or storing the crop as silage are all practices which help to retain leaves. Legumes also add organic matter and nitrogen to the soil when plowed down. See Table 62 for nitrogen adjustments.

Fall Management Alfalfa, and all other legumes must store food reserves in their roots during the fall to prevent them from killing over winter. Such food makes the plant resistant to low winter temperatures and is used also to initiate new growth in the spring and after each harvest. Each region in the province has a period in the fall when cutting or grazing will weaken plants to the level where they will either winter-kill severely or succeeding yields will be greatly reduced. This period is known as the **Critical Fall Harvest Period** and is shown for Ontario in Figure 2. In addition, leaving a foot or more of top growth for winte is excellent insurance against winterkilling.

LEGUMES

ALFALFA

Alfalfa-based mixtures are intended for use in stored-feed and green feeding programs because they produce more hay, silage or green chop than any other mixture. Given good management including adequate phosphorus, potash and proper cutting management, high yields of quality livestock feed will be produced for up to four years. When used as pasture, these mixtures are for short- term stands only because alfalfa may thin out in two or three years. For the highest production and best persistence, alfalfa mixtures should be used on well- drained soils. This condition does eliminate the economic use of alfalfa on many heavy clay soil types of the clay belt of northern Ontario.

Both early and medium maturing alfalfa-based mixtures can be used on the farm to permit staggering of the harvest dates. The early maturing varieties develop quickly in the spring and provide more and earlier aftermath than medium maturing varieties.

There are no significant differences in protein level between alfalfa varieties. The major factor influencing protein level of alfalfa is the data of harvest. As the plant matures, the percentage of protein decreases. Attempts to develop varieties with a higher protein percentage have resulted in unacceptable lowering of yield.

CROP MANAGEMENT

1. Alfalfa-based mixtures may be seeded with or without a companion crop. Where high forage yields are required in the seeding year **do not** use a companion crop. Weeds must be controlled. When a companion crop is desired use oats at 60 kg/ha preferably in 36 cm rows. Remove the oat crop when knee-high by controlled grazing or at the early dough stage for stored feed if forage establishment is a problem.

2. For stored feed cut at very first flower stage to obtain high quality feed.

3. For pasture, alfalfa must not be overgrazed. Rotational or strip grazing with four- to five-week rest periods improves the persistence of the stand.

4. High soil levels of phosphorus and potassium are required for high yields and maintenance of the stand. See Fertilizers for Forage Crops.

5. Alfalfa is particularly sensitive to cutting or grazing during September and October. Succeeding yields and persistence can be severely reduced if harvests occur during the critical fall harvest.

6. The life expectancy of alfalfa under favorable field conditions varies from two to five years. Long life can be expected where only two harvests as stored feed are taken annually, but a shorter life span is found where aftermaths of hay meadows are grazed or alfalfa is used in pasture mixtures.

ALFALFA VARIETY SELECTION

All recommended alfalfa varieties are resistant to bacterial wilt. Only one recommended variety, **Trumpetor**, shows promising resistance to verticillium wilt. There are several recommended varieties with partial resistance to phytophthora root rot. For more information on these diseases, see Disease and Insect Control in Forage Crops.

Table 8. Alfalfa Varieties Resistant to Phytophthora Root Rot

Variety	% Plants Resistant to Phytophthora
Answer	66
Apollo	40
Peak	49
Trident	71
120	39

Table 9. Recommended Alfalfa-Based Mixtures

Components	Seeding Rate[1] kg/ha	Use Recommendation
Alfalfa alone	13	Use only on fields where alfalfa is known to do well. High levels of fertility are necessary. Harvest at first flower stage and store as haylage or hay. For 20% or higher crude protein feed, harvest when the flower buds appear.
Alfalfa Bromegrass	11 9	An excellent hay, silage or green chop mixture. Recommended over alfalfa-timothy for farms having more than 3100 heat units and dry soils. Use early or medium-maturing alfalfa varieties.
Alfalfa Timothy	11 6	Use where aftermath is not required as pasture, but where high quality stored feed is the main consideration. Use this high producing mixture as one of a series to diversify the maturity date of mixtures on the farm.
Alfalfa Orchard	11 6	Use on part of acreage where cutting and/or grazing can be matched with maturity of the varieties used. This early maturing mixture demands early cutting for high digestibility and to best utilize the rapid recovery and high aftermath yield. Use early varieties only. Where ladino is adapted, 0.5 kg ladino can be added.
Alfalfa Ladino Timothy Bromegrass	9 2 4 9	For use as part of the pasture acreage or where hay aftermath is to be grazed. Use in combination with mixtures containing orchard to help the pasture production period.

Continued on Page 18

Table 9. Recommended Alfalfa-Based Mixtures (Cont'd.)

Components	Seeding Rate[1] kg/ha	Use Recommendation
Alfalfa Ladino Orchard Bromegrass	9 2 3 9	Use in conjuction with above mixture to spread pasture production. Alfalfa, orchard and brome give good production under dry conditions.
Alfalfa Ladino Orchard	9 2 9	For use under pasture or hay-pasture conditions. High fertility and good management are necessary for top production. Alfalfa is included as insurance against dry conditions. See white clover-orchard mixtures in White Clover section.

1 *For early seeding on a fine, firm seedbed, these rates may be reduced by 25% except where coated seed is being used. On farms where these mixtures result in stands with too much grass, reduce the grass seeding rate by up to 50%.*

Table 10. Recommended Alfalfa Varieties

Variety	Distributor[1]	Variety	Distributor[1]
EARLY ALFALFA		**MEDIUM ALFALFA**	
Anchor	Oseco Inc.	Algonquin	Public variety
Angus	Public variety	120	Dekalb Canada
Answer	Speare Seeds	Glory	Speare Seeds, Bishop Seeds
Apica	United Co-ops of Ontario	Iroquois	Public variety
Apollo	Oseco Inc., PAG Seeds	Magnum	Rothwell Seeds
Banner	Pioneer Hi-Bred	Pickstar	Otto Pick & Sons Seed
Ceres	Speare Seeds, King Grain	524	Pioneer Hi-Bred
Citation	Mapleseed Inc.	526	Pioneer Hi-Bred
Classic	United Co-ops of Ontario	Titan	Oseco Inc.
130	Dekalb Canada	Valor	Rothwell Seeds
Hunter	Otto Pick & Sons Seeds	Vernal	Public variety
Pacer	Bishop Seeds, Oseco Inc. General Seed Co.	WL215	King Grain, Speare Seeds
Peak	Oseco Farm Seed Centre	Weevlcheck	United Co-ops of Ontario
532	Pioneer Hi-Bred		
Primal	King Grain		
Regal	United Co-ops of Ontario		
Saranac	Public variety		
Thor	Northrup King Seeds		
Trident	PAG Seeds		
Trumpetor	Northrup King Seeds		
Turbo	Otto Pick & Sons Seeds		
Vista	Otto Pick & Sons Seeds		

1 *See Distributor Addresses in General Information section.*

Table 11. Early Alfalfa Variety Yields

Variety	Yield (as % of Saranac) Southern Ontario	Northern Ontario
	%	%
Saranac	100	100
Anchor	99	97
Anaus	98	100
Answer	98	91
Apica	106	-
Apollo	98	90
Banner	103	99
Ceres	100	91
Citation	103	108
Classic	100	96
130	102	-
Hunter	100	-
Pacer	99	96
Peak	101	-
532	105	-
Primal	102	100
Regal	104	-
Thor	100	98
Trident	99	97
Trumpetor	100	-
Turbo	101	-
Vista	100	98

Average yield of Saranac in southern Ontario trials 12.2t/ha; in northern Ontario trials 7.9 t/ha.

Table 12. Medium Alfalfa Variety Yields

Variety	Yield (as % of Iroquois) Southern Ontario	Northern Ontario
	%	%
Iroquois	100	100
Algonquin	97	100
120	102	98
Glory	104	-
Magnum	102	93
Pickstar	97	96
524	101	89
526	104	-
Titan	97	100
Valor	99	99
Vernal	98	97
WL215	96	90
Weevlchek	99	90

Average yield of Iroquois in southern Ontario trials 12.3t/ha; in northern Ontario trials, 6.4t/ha.

BIRD'S-FOOT TREFOIL

Under good fertility and well-drained conditions, established trefoil annually produces less forage than alfalfa. However, trefoil stands have been known to be productive for 20 years. The no-bloat feature makes trefoil an excellent long-term pasture legume.

Trefoil-based mixtures can be used in pasture, stored feed or green chop programs. They should be used only for stands of three or more years duration. Trefoil-based mixtures perform and persist very well on steep, rolling or stoney land, or under wet or acid conditions.

Management

1. Where normal tillage equipment can be used to prepare a seedbed and establish trefoil using the direct seeding method, seed early in spring, do not use a companion crop, control weeds and apply up to 15 kg/ha of nitrogen with the necessary phosphate and potash. (See Fertilizers for Forage Crops). On fields which have not previously grown trefoil, innoculation of the seed with rhizobium bacteria is essential. The innoculant must be specific for trefoil, and must be fresh-dated to insure viability.

2. For hay or silage, harvest at the early flower stage of growth.

3. For pasture do not graze until trefoil is 25 to 30 cm high in the spring, except in northern Ontario, where grazing can begin when trefoil is 15 to 20 cm high. For best results use rotational rather than continuous grazing.

4. Trefoil is as sensitive as alfalfa to fall grazings or harvests. Succeeding year's yields are reduced if heavy grazing or harvesting occurs during the critical fall period. (See Figure 2). In Northern Ontario, dates shown for alfalfa may be applied to trefoil. In Southern Ontario, the critical date for trefoil is about 10 days earlier than for alfalfa at any given location.

5. Trefoil stands often require one year following the seedling year to reach maximum productivity. This is particularly true when trefoil is seeded under a companion crop.

Bird's-Foot Trefoil Variety Selection

Four varieties are now recommended in Ontario. These varieties differ in their ability to withstand flooding and poor drainage. They also differ in seeding vigor, growth habit, maturity and hardiness. Differences in yield potential are small and are less significant in variety selections than are differences in drainage tolerance and maturity.

Table 13. Recommended Bird's-Foot Trefoil Varieties

Variety	First Flower (Guelph)	First Flower (Kapuskasing)	Major Use	Regrowth	Variable Drainage Tolerance	Hardiness	Distributor[1]
Viking	June 15	June 25	Hay	Med	Fair	Good	Public Variety
Maitland	June 16	June 27	Hay	Med	Fair	Good	Maple-seed Inc., Otto Pick & Sons Seeds
Leo	June 23	June 30	Pasture or Hay	Med	Excellent	Excellent	Public Variety
Empire	July 1	July 7	Pasture or hay	Slow	Excellent	Excellent	Public Variety

1 *See Distributor Addresses in General Information section.*

Table 14. Bird's-Foot Trefoil Variety Yields

Variety	Yield (as % of Leo) Southern Ontario	Northern Ontario
	%	%
Leo	100	100
Empire	97	93
Maitland	99	92
Viking	97	91

Average yield of Leo in southern Ontario trials 8.5 t/ha; in northern Ontario trials, 5.8 t/ha.

Table 15. Recommended Bird's-Foot Trefoil-Based Mixtures

Components	Seeding Rate[1] kg/ha	Expected Life (years)	Use Recommendation
Trefoil Timothy	9 2	5+	For long term pastures, early or late maturing hay. Free from bloat. Choose varieties for desired maturity and drainage conditions.
Trefoil alone	11	5+	For renovating or overseeding pastures. For high protein stored feed cut at the late bud stage. Stand may not last five years under this cutting system. Direct seedings preferred.
Trefoil Bromegrass	9 5	5+	Graze early to reduce brome competition. Take hay from regrowth only. Fall growth may be pastured.

1 *For early seeding on a fine, firm seedbed, these rates may be reduced by 25% except where coated seed is being used.*

RED CLOVER

Red clover-based mixtures are short-term mixtures best used for stored-feed production. Red clover produces well in the year following seeding, but usually thins by the second harvest year and rarely survives for a third harvest year. Timothy is the best grass to use with red clover. Red clover is difficult to cure as hay, but makes excellent haylage. It is not recommended in pasture mixtures because of the bloat hazard and poor persistance.

Red Clover Types

Double-cut or medium red clover is the most popular type with farmers. It will flower in the seeding year and in the first and second cut in the succeeding years. The regrowth after cutting is strong and vigorous.

Single-cut or mammoth red clover is slower growing with larger stems and matures about two weeks later than the double-cut. It does not flower in the seeding year or in the slow growing, low yielding leafy aftermath in succeeding years.

Red Clover Variety Selection

The recommended double-cut varieties of red clover are somewhat more persistent in the second production year than is commercial Canadian double- cut, and are particularly recommended where stands will be harvested for two years.

Red Clover Plow-down

Plow-down red clover is red clover seeded with or without a companion crop and plowed down in late October of the establishrnent year or early the next spring. When used in this manner a full stand 15 cm in height at fall plowing can contribute excellent soil tilth and substantial nitrogen to the following crop (see Nitrogen Adjustment for Legumes

Plowed Down). By late fall, when seeded under an early-removed, grain companion crop, double-cut red clover can produce two tonnes of top growth and two tonnes of root dry matter per hectare which will average 3% nitrogen. Generally double-cut red clover produces more top-growth than single-cut and thus will provide more nitrogen for the following crop. Inoculation of the seed with the appropriate Rhizobium culture will ensure the nitrogen contribution.

Red clover has a vigorous seedling which establishes easier than alfalfa. When establishing red clover under spring grain, it is preferable to seed early to avoid lodging of the grain crop and harvest problems. Red clover seed may be broadcast directly or included in the spring application of dry or liquid nitrogen on winter wheat.

Table 16. Recommended Double-Cut Red Clover Varieties

Variety	First Flower (Guelph)	First Flower (Kapuskasing)	Regrowth	Variable Drainage Tolerance	Distributor[1]
Arlington	June 15	June 29	Med	Good	Public variety
Florex	June 18	July 2	Med	Good	Northrup King Seeds Otto Pick & Sons Seeds Mapleseed Inc.
Lakeland	June 18	July 2	Med	Good	Public variety
Ottawa	June 18	June 29	Med	Good	Public variety
Prosper I	June 18	July 2	Med	Good	King Grain

1 *See Distributor Addresses in General Information section.*

Table 17. Red Clover Variety Yields

Variety	Yield (as % of Florex) Southern Ontario	Northern Ontario
Florex	100	100
Arlington	97	90
Lakeland	88	93
Ottawa	89	87
Prosper I	97	96

Average yield of Florex in southern Ontario trials 9.9 t/ha; in northern Ontario trials 5.8 t/ha.

Table 18. Recommended Red Clover-Based Mixtures

Components	Seeding Rate[1] kg/ha	Expected Life (years)	Use Recommendation
Red Clover Alsike Timothy	7 2 6	1 to 2	For short-term hay. Less clover can be expected in the second year. When clovers disappear, plow, or fertilize with nitrogen in order to maintain production. Alsike is more tolerant of acid soils and poor drainage.
Red Clover Timothy	7 6	1 to 2	For short-term stands of hay. When clovers disappears, plow, or fertilize with nitrogen in order to maintain production.
Red Clover	11	1	Short-term hay, seed and/or plow-down crop. Plow in the seeding or after the first production year. Follow with corn, a row crop or cereals to utilize the nitrogen contributed by the clover.

1 *For early seeding on a fine, firm seedbed, these rates may be reduced by 25% except where coated seed is being used.*

WHITE CLOVER

White clover mixtures perform best as pastures, particularly in areas where moisture is plentiful and winterkilling is not a problem. They are difficult to cure as hay. Ladino is the large tall-growing type of white clover, and is the type of white clover recommended in Ontario. It tolerates variable drainage conditions. Because it flowers in early June and regrows rapidly, it performs well in combinations with orchard grass to give an early maturing mixture. Including an early productive grass such as orchard grass in a white clover based pasture mixture can help to reduce the bloat hazard.

Management

1. Control grazing in autumn to leave protective cover of grass leaves on overwintering creeping stems of ladino.

2. Controlled grazing management helps the stand remain productive for a period of years.

White Clover Variety Selection. **Sacramento** is the ladino type white clover variety presently recommended in Ontario.

Table 19. Recommended White Clover-Based Mixtures

Components	Seeding Rate[1] kg/ha	Expected Life (years)	Use Recommendations
White clover (Ladino type)	2	3	For pasture use where white clover is adapted. High fertility and good management required for top production. In dry areas add alfalfa. See alfalfa ladino orchard mixture in Table 10.
Orchard	9		

1 *For early seeding on a fine, firm seedbed, these rates may be reduced by 25% except where coated seed is being used.*

GRASSES

Generally, legume grass mixtures are more productive than grasses grown alone. However, pure grass stands may be more productive than legumes on poorly drained soils, under acid soil conditions, or under climatic or management conditions unfavorable to legumes.

Orchard grass, bromegrass, timothy and mixtures of these can be used in areas where early pasture is required.

When cut at the "heads emerging" stage for stored feed, grasses are as high in digestible energy as legumes. If fertilized with nitrogen their crude protein content may range from 12 to 15%. Reed canary grass should be used on very poorly drained areas when long-term stands are desired. All grass stands require nitrogen, phosphate and potash to be productive. (See Fertilizers for Forage Crops.)

Management

1. Successful seeding of pure grass can best be obtained by seeding in early spring. Seeding after midsummer reduces the chance for successful establishment. Use a complete fertilizer (Nitrogen, Phosphate and Potash) at seeding time.

2. Harvest grasses at the "heads just emerged" stage of growth for top quality stored feed.

3. Apply recommended rates of nitrogen early each spring and after each cutting or grazing. See Table 27.

4. Apply phosphate and potash each fall at rates indicated by soil test. See recommendations in Fertilizers for Forage Crops.

Table 20. Recommended Pure Grass Seeding Rates

Pure Stand of	Seeding Rate kg/ha
Reed Canary	9
Brome	11
Timothy	9
Orchard	9

BROMEGRASS

This grass species is important for early and late cut hay. When harvested at the recommended "heads emerged" stage, it is higher in digestibility and much earlier maturing than timothy. As bromegrass advances in maturity, its digestibility decreases at a slower rate than other grasses. Bromegrass produces slightly more aftermath than timothy and combines well with alfalfa in legume-grass mixtures.

For early pasture bromegrass is excellent. Used in mixtures it permits early grazing in the spring and produces good growth in the fall. Use only recommended varieties. Seeding must be shallow, no deeper than 1 - 2 cm.

ORCHARD GRASS

This grass is an early maturing forage that grows rapidly under a high nitrogen fertilization program. It is cut for stored feed when the heads are just emerging from the boot. All varieties are adapted to silage and pasture mixtures. The later varieties will combine better with alfalfa for hay or hay- pasture mixtures.

Orchard grass grows back rapidly after cutting or grazing. It is our best grass for aftermath production during the hot, drier summer period. It will reduce the bloating effect of alfalfa and the clovers when grown in mixtures. For pasture, the maturing stems and heads should be clipped in late May or in early June to maintain leafy, palatable growth.

Orchard grass requires well-drained soils to perform adequately. Surface drainage is necessary as ice conditions or flooding will kill orchard grass.

TIMOTHY

The basic meadow grass in Ontario - timothy - grows under a wider range of environments than any other grass used, and is easy to establish and maintain. Alfalfa-timothy mixtures are among the most popular and productive mixtures for stored feed. Timothy is well adapted to the heavier soil types and variably drained fields. Cut for hay at the heading stage, timothy is a high-yielding quality grass. Like all grasses, in a mixture it contains about half the crude protein of alfalfa. For pasture or hay aftermath, timothy is a lower producer than orchard or brome. Palatable and high-yielding in the spring, it grows back slowly after cutting or grazing, and most varieties produce relatively poor growth during the dry midsummer. However, since timothy adds stand insurance, small to moderate amounts are useful when making new seedlings with legume.

REED CANARY GRASS

This grass species tolerates excessive moisture and is highly productive for long-term hay or pasture on poorly drained soils, or areas subject to prolonged periods of flooding. It is also adapted to dry upland soils. Reed canary grass is less palatable than other grasses and, if allowed to mature, is tall and coarse. When grazed heavily enough to prevent heading, reed canary grass is a good pasture producer.

For stored feed reed canary grass is more acceptable to livestock when stored as silage or haylage, rather than dry hay, due to its coarse growth habit.

Table 21. Recommended Grass Varieties

Variety	Heading Date (Guelph)	Heading Date (Kapuskasing)	Aftermath Production	Tolerance to Variable Drainage	Distributor[1]
Bromegrass					
Baylor	June 10	June 26	Good	Fair	Oseco Inc.
Beacon	June 10	June 25	Good	Fair	Oseco Inc., United Co-ops of Ontario
Blair	June 10	June 24	Good	Fair	Mapleseed Inc.
Bromex	June 10	June 26	Good	Fair	Northrup King Seeds
Saratoga	June 10	June 24	Good	Fair	Public
Tempo	June 10	June 24	Good	Fair	Otto Pick & Sons Seeds
Orchard Grass					
Hallmark	June 2	June 15	Excellent	Poor	United Co-ops of Ontario
Juno	June 2	June 15	Excellent	Poor	Mapleseed Inc., Otto Pick & Sons Seeds
Ina	June 8	June 15	Excellent	Poor	Otto Pick & Sons Seeds
Napier	June 8	June 16	Excellent	Poor	Oseco Inc.
Sumas	June 12	June 18	Excellent	Poor	Oseco Inc.
Kay	June 12	June 18	Excellent	Poor	Oseco Inc.
Timothy					
Salvo	June 16	June 22	Good	Good	Public SeCan
Toro	June 20	July 3	Good	Good	Oseco Inc.
Basho	June 22	July 2	Good	Good	Public
Richmond	June 22	July 2	Fair	Good	Mapleseed Inc., Otto Pick & Sons Seeds
Champ	June 23	July 1	Good	Good	Public
Itasca	June 25	July 3	Fair	Good	United Co-ops of Ontario
Timfor	June 28	July 3	Fair	Good	Northrup King Seeds
Climax	June 28	July 5	Fair	Good	Public
Pronto	July 1	July 3	Fair	Good	King Grain
Reed Canary Grass					
Frontier	June 10	June 24	Excellent	Excellent	Public
Vantage	June 10	June 24	Excellent	Excellent	Oseco Inc.

[1] *See Distributor Addresses in General Information section.*

THE BLUEGRASSES

Two common bluegrasses in Ontario, Canada and Kentucky, grow on about one million hectares of permanent pasture land. Much of this pasture is low in production but can be improved by renovation, fertilization and weed control. The dense but shallow rooted bluegrasses produce lush, palatable growth during the springtime but low yields during the dry, hot midsummer in southern Ontario.

Properly fertilized and managed, their production can be markedly improved, especially in the cooler climate of northern Ontario. In horse pastures, they serve as a bottom grass that controls weed invasion, withstands close grazing and tramping, and creeps and fills in where other species thin out.

CREEPING RED FESCUE

Creeping red fescue establishes well on a wide range of soil types and will establish plants also on well-fertilized subsoil. It spreads vigorously on ditch banks with a solid underground root system. Such roots hold the soil from underneath while the thick, fine, leafy top growth protects the soil surface against water movement. These characteristics, plus its low growth, make it very useful for stabilizing soils on ditch and creek banks and on grass waterways. Creeping red fescue survives well in long term pastures.

TALL FESCUE

Tall fescue is not readily grazed by livestock during much of the year, consequently, it provides substantial amounts of coarse, leafy, top growth in paddocks and loafing areas. It is adapted to most soil types, tolerant to imperfect drainage, and has the ability to withstand considerable tramping because it has an extensive and vigorous root system. It grows well throughout the year, particularly in the fall when its palatability generally improves.

Tall fescue is a useful species for erosion control.

Table 22. Timothy Variety Yields

Variety	Yield (as % of Climax) Southern Ontario	Northern Ontario
	%	%
Climax	100	100
Basho	100	100
Champ	99	107
Itasca	101	104
Pronto	97	101
Richmond	99	99
Salvo	98	101
Timfor	101	103
Toro	99	100

Average yield of Climax, southern Ontario trials 10.8 t/ha; in northern Ontario trials 6.4 t/ha.

Table 23. Orchard Grass Variety Yields

Variety	Yield (as % of Hallmark) Southern Ontario	Northern Ontario
	%	%
Hallmark	100	100
Ina	98	96
Juno	98	98
Kay	103	105
Napier	102	91
Sumas	103	104

Average yield of Hallmark in southern Ontario trials 9.8 t/ha; in northern Ontario trials 6.2 t/ha.

Table 24. Bromegrass Variety Yields

Variety	Yield (as % of Baylor) Southern Ontario	Northern Ontario
	%	%
Baylor	100	100
Beacon	100	104
Blair	99	—
Bromex	97	97
Saratoga	99	94
Tempo	96	103

Average yield of Baylor in southern Ontario trials 10.1 t/ha; in northern Ontario trials 8.6 t/ha.

Table 25. Reed Canary Grass Variety Yields

Variety	Yield (as % of Frontier) Southern Ontario	Northern Ontario
	%	%
Frontier	100	100
Vantage	103	93

Average yield of Frontier in southern Ontario trials 11.6 t/ha; in northern Ontario trials 9.0 t/ha.

ANNUAL CROPS FOR FORAGE IN SOUTHERN ONTARIO

SPRING PASTURE

Autumn-seeded fall rye or **winter triticale** can be grazed for a short period in the spring, preferably after the stems start to form. Seed fall rye at 150 kg/ha, and winter triticale at 100-125 kg/ha. Keep stock off when wet. Another pasture or green chop crop (e.g. corn or sorghums) may follow the rye for summer feed in intensive programs.

SUMMER GREEN CHOP OR PASTURE

Corn Use hybrid seed at normal rates for standard rowwidths, or grain corn from the crib if germination is satisfactory for solid-stand grain drill plantings. In the latter case, 70 kg of seed per hectare is adequate for 18 cm drills. Early planting is preferred. No aftermath can be expected. Use for green chop. Harvest should commence at about tasselling time.

Sudan Grass Hybrids, Sorghum Hybrids, Sorghum-Sudan Hybrids Seed from mid May to early June at about 14 kg/ha in 18 or 36 cm drill rows. The crop is ready for green chop or grazing by late July-August. Do not graze before 75 cm high or during severe stress as **prussic acid poisoning** could occur. If frozen, allow three days following frost before grazing again to avoid prussic acid poisoning. Aftermath yields are moderate but high if warm moist weather prevails. Under good nitrogen fertility, these crops can produce large quantities of nutritious, palatable herbage. They are particularly useful on dairy farms to supplement normal pastures during August and September.
These hybrids are not recommended in short season areas because of inconsistent yields and danger of prussic acid poisoning.

Oats or Barley Seed any time in the season to produce pasture in six to eight weeks. See 1 at 100 kg/ha. Graze when stems are forming. No aftermath can be expected.

AUTUMN PASTURE

Oats Seeded at 100 kg/ha between mid July and mid August, ready for grazing in six weeks.

Fodder rape Seed in early July at 1.7 kg/ha in 71 cm rows. May be seeded in solid stands, but yields are 25% lower. Pasture in late October. Makes good hog, sheep, or beef pasture. Taints milk.

Marrowstem kale Seed by early June on clean fields well supplied with nitrogen (85 kg/ha). Solid seedings at 7 kg/ha give good yields for grazing in August and September; 71 cm row seedings for grazing in October and November. Kale is palatable to all classes of livestock. Moderate intakes will not produce off-flavors in milk. The varieties **Maris Kestrel** and **Gruner Angelites** are recommended.

Fall rye Seeded by August 1, at 150 kg/ha, gives good fall pasture by October 1.

SILAGE CROPS

Corn is the most productive silage crop. Any of the cereals make satisfactory silage harvested by the early dough stage. The sudan grass, sorghum and sorghum-sudan hybrids can also be made into silage.

FORAGES FOR EROSION CONTROL

Most of the grass and the legume species used for livestock forages can be used for erosion control and soil conservation purposes to stabilize soil, to prevent weed infestation and to provide an attractive appearance. When selecting species or mixture consider the factors of permanence, adaptability to the particular location, moisture, soil characteristics, use of the area, frequency of mowing. Grasses with creeping root systems (rhizomous) are preferred to bunch grasses. Legumes contribute nitrogen. Recommended species and mixtures are given under Special Purpose Mixtures.

Table 26. Special Purpose Mixtures

Use	Components	Seeding Rate kg per hectare	Comments
Horse pasture	Alfalfa	9	Early spring seeding is preferred.
	White clover	2	
	Timothy	5	
	Bromegrass	9	
	Kentucky bluegrass	5	
Horse paddock Dairy Holding Area	Tall Fescue	14	Early spring seeding is preferred. For exercise area only. Clip if necessary.
Ditch banks	Trefoil (Empire Type)	13	Early spring seeding is preferred.
	Creeping Red Fescue	20	Apply 2 cm of straw as a mulch.

Table 26. Special Purpose Mixtures (Cont'd.)

Use	Components	Seeding Rate kg per hectare	Comments
	Tall Fescue	45	Best results are obtained by seeding immediately after digging or reshaping. Late summer or early fall seedings are preferred. Mulch spring and early summer seedings with 2 cm straw to prevent drying out.
Waterways	Any of the Alfalfa or Trefoil based mixtures (pages 17 to 22)		These mixtures can be used and harvested for stored-feed where standing water is not a problem and the slope not too severe. Otherwise the Trefoil-Fescue mixture or Tall Fescue should be used.
	Tall Fescue	22	Tall fescue is a tough sod forming grass which can withstand wear by livestock and farm machinery. It is recommended for erosion control on diversion terraces, grass waterways, and farm pond dams.

FERTILIZERS FOR FORAGE CROPS

Fertilizer requirements for forages in Ontario can best be estimated by using a soil test along with information on the species grown and past management such as manure. Fertilizer recommendations are based on the results of trials run on research stations and farm fields in Ontario. The recommendations in this publication can be expected to produce highest economic returns from the crop when good or above average management is used.

To provide dependable fertilizer recommendations each field should be tested at least once every third year. When large amounts of nutrients are removed from sandy soils (with crops such as hay, corn silage, potatoes or tomatoes) and manure is not applied, annual testing is advisable as potash soil tests can change rapidly under those conditions.

Where a soil test is not available, a rough estimate of requirements can be obtained from Tables 30 and 31 using the following guidelines:

a. Where the field has been fertilized regularly for a number of years or heavily in recent years, use one of the rates of phosphate and potash recommended for the MEDIUM soil test rating (see Tables 29 and 30).

b. If the field has received little fertilizer in the past, use one of the rates recommended for a LOW soil test rating (see Tables 29 and 30).

Table 27. Nitrogen Requirement Table for Improved Grass Hay or Pasture

Value of Grass		Application	Cost of Nitrogen Fertilizer - ¢/kg (¢/lb)			
Hay @ 15% Moisture		No.[2]	60 (27.2)	70 (31.7)	80 (36.3)	90 (40.8)
$/tonne	($/ton)		(kg N/ha)[1]			
30.00	(27.22)	1	95	75	69	45
		2	75	60	50	35
		3	60	50	40	30
50.00	(45.36)	1	130	125	115	105
		2	105	100	90	80
		3	85	80	70	65
70.00	(63.50)	1	150	140	135	130
		2	120	115	110	100
		3	95	90	85	80

10 tonne = 11 ton, 100 kg/ha = 90 lb/ac.

1 *All rates should be reduced by one third where the crop is to be harvested by grazing because of recycling through manure and urine. Where manure is applied to machine harvested forage, reduce the fertilizer application according to the amount and quality of manure (see Manure in Soils section).*

2
1. *First application to be made prior to May 10.*
2. *Second application to be made after the first cut.*
3. *Third application to be made after the second cut only if there is reasonable assurance of a third cut.*

Table 28. General Nitrogen Requirements - Perennial Forages

Crops	N Required kg/ha[1]
Legume or legume-grass at seeding - with or without companion crop	15
Unimproved pasture	50
Grass for seed	90
Hay or pasture - 1/2 or more legume	0
Hay or pasture - 1/3 to 1/2 legume	60
Hay or pasture - grass (less than 1/3 legume)	(See Table 27)

1 *100 Kg/ha = 90 lb/ac.*

Nitrogen

No soil test is available which is satisfactory for nitrogen under Ontario conditions. Nitrogen fertilizer recommendations are therefore based on the crop and adjusted

downward if manure is applied. Stands containing half or more legume do not require nitrogen fertilizers.

Grass stands containing less than one-third legume require large amounts of nitrogen. Where conditions permit, therefore, it is generally more profitable to reseed to mixtures containing legumes. It can be profitable, however, to fertilize grass stands consisting of productive species such as brome, orchard, or timothy. The use of nitrogen will also increase the protein level in the grass. The rates of nitrogen recommended for grass stands have been developed on the basis of the price of nitrogen relative to the value of hay (see Table 28). The first application for hay or pasture should be made as early as possible in the spring, followed by a second application after the first cutting and a third application after the second cutting. To avoid the danger of nitrate toxicity no more than 170 kg of N per ha should be applied at any one time.

Phosphate and Potash

Phosphate and potash requirements for forages are presented in Tables 29 and 30. These recommendations are based on soil tests conducted by the Ontario Ministry of Agriculture and Food soil testing laboratory at the Department of Land Resource Science, University of Guelph. These tables should not be used with soil test readings from other soil testing laboratories unless the methods used are identical to those used in the OMAF laboratory.

Some clay and clay loam soils are naturally high in potassium and do not require any potash fertilizers. Only a soil test can adequately determine potash requirements.

When direct seeding on soils which require phosphate fertilizer, establishment may be improved by the placement of a high phosphate fertilizer 5 cm directly below the seed. Using a grain drill with fertilizer and grass seed attachments, this placement may be accomplished by drilling the fertilizer through the furrow opener and dropping the forage seed on a firm soil surface directly behind the furrow opener. Usually it is advisable to firm the soil surface immediately after seeding.

The timing of fertilizer application to established forage stands may influence the response obtained. Potassium, where required, is best applied after the last harvest prior to the fall rest period (see Fall Management). Phosphorus, if required, may be applied with the potassium in the fall or applied separately in the spring or summer.

Manure

Manure is an excellent source of nutrients and can substitute for manufactured fertilizers. It is an excellent source of nitrogen for grasses but forage legumes do not make efficient use of manure nitrogen. Do not apply manure to perennial forage legumes when there is snow cover because ice frequently forms under the manure and can kill the plants (see Manure in Soils section).

Liming

Legumes generally are not tolerant of acid soil conditions. Acid soils (pH 6.0 or lower) should be limed one year before seeding, at rates indicated by soil tests.

Micronutrients

The micronutrient boron is particularly important for alfalfa. However, boron fertilizer applications are not required on all soils. Boron deficiency of alfalfa shows up mainly on high pH sandy soils. Boron applications are recommended on all sandy soils and in particular, the sandy loam and loam soils in the area east of the Niagara Escarpment to and including Frontenac County.

Continued on Page 36

Table 29. Phosphate Requirements for Forages Based on OMAF Soil Tests

	At seeding with or without nurse crop		Forages at seeding-hand seeded[1]		Established hay or pasture		Unimproved pasture	
Phosphorus Soil test	Rating	Phosphate (P_2O_5)[2] Required kg/ha	Rating	Phosphate (P_2O_5)[2] Required kg/ha	Rating	Phosphate (P_2O_5)[2] Required kg/ha	Rating	Phosphate (P_2O_5)[2] Required kg/ha
0 - 3	LOW	130	LOW	130	LOW	90	LOW	70
4 - 5		110		110		70		60
6 - 7		90		90		60		50
8 - 9		70		70		50		30
10 - 12	MEDIUM	50	MEDIUM	50	MEDIUM	30	MEDIUM	20
13 - 15		30		40		20		20
16 - 20		20		30		0		0
21 - 25		20	HIGH	20	HIGH	0	HIGH	0
26 - 30	HIGH	0		20		0		0
31 - 40		0		20		0		0
41 - 50	VERY HIGH	0		20	VERY HIGH	0	VERY HIGH	0
51 - 60		0	VERY HIGH	0		0		0
61+	EXCESSIVE[3]	0	EXCESSIVE[3]	0	EXCESSIVE[3]	0	EXCESSIVE[3]	0

100 kg/ha = 90 lb/ac

1 *For use only where seed is banded directly above the drilled fertilizer.*

2 *Where manure is applied, reduce the fertilizer application according to the amount and quality of manure (see Manure in Soils section). Examples of fertilizer application: An established stand of hay containing over 50% alfalfa would require no nitrogen (see table above). If it were not manured and the soil tests were 14 phosphorus and 65 for potassium, the phosphate requirement would be 20 kg/ha (from above table) and the potash requirement 70 kg/ha (Table 31). This could be supplied by broadcasting 45 kg/ha (20 ÷ 46 x 100) of 0-46-0 and 120 kg/ha (70 ÷ 60 x 100) of 0-0-60 prior to the fall rest period.*

3 *Excessive readings may cause reduced yield or affect nutrient balance in crops and increase the risk of water pollution.*

Table 30. Potash Requirements for Forages Based on OMAF Soil Tests

	At Seeding with or without nurse crop		Fall applications for new seeding and established stands			
			Alfalfa[2]		Other Forages	
Potassium Soil Test	Rating	Potash (K_2O)[1] Required kg/ha	Rating	Potash (K_2O)[1] Required kg/ha	Rating	Potash (K_2O)[1] Required kg/ha
0 - 15	LOW	90	LOW	480	LOW	250
16 - 30		80		400		220
31 - 45		70		320		190
46 - 60		50		250		160
61 - 80		40		200		120
81 - 100	MEDIUM	30	MEDIUM	120	MEDIUM	90
101 - 120		20		70		70
121 - 150		20		40		40
151 - 180	HIGH	0	HIGH	0	HIGH	0
181 - 250	VERY HIGH	0	VERY HIGH	0	VERY HIGH	0
251+	EXCESSIVE[3]	0	EXCESSIVE[3]	0	EXCESSIVE[3]	0

100 kg/ha = 90 lb/ac

1 *Where manure is applied, reduce the fertilizer according to the amount and quality of manure (see Manure Section).*

2 *Stands of 50% Alfalfa or more. Stands of less than 50% Alfalfa should be fertilized the same as other forages.*

3 *Excessive ratings may cause reduced yield or quality of crops primarily due to magnesium deficiency. Natural levels above 251 occur occasionally on clay and clay loam soils, but are not expected to cause problems because soils naturally high in potassium are usually high in magnesium.*

Micronutrients (Cont'd. from Page 33)

A shortage of available boron to the alfalfa plant first affects flowering and reduces seed-set. As the deficiency becomes more serious, the youngest upper leaves of the plant become yellow to red in color in different plants. Growth can be severely stunted and winter hardiness reduced.

Boron deficiency can usually be corrected or prevented by an application of 1.0 to 2.0 kg boron/hectare broadcast annually.

Mixtures of herbicides and fertilizers should not be applied to crop foliage unless recommended by competent authorities.

For further details on boron deficiency and on methods of application see OMAF Factsheet, *Boron Requirements of Alfalfa*, Agdex 121/531.

DISEASE AND INSECT CONTROL IN FORAGE CROPS

(See also Pesticides Section)

DISEASES

Phytophthora root rot is a soil-borne disease which can result in root injury or death of alfalfa plants. Young plants in new seedings are particularly prone to damage. The disease shows up in Ontario mainly on poorly drained soils or on clay loam soils during extended periods of wet weather.

Consult the section **Alfalfa Variety Selection** for a list of recommended varieties with some resistance to this disease.

Verticillium Wilt of alfalfa continued to spread in 1983 and now can be found in many areas of southern Ontario west of Toronto. The disease is serious in western seed producing areas. To prevent introduction of Verticillium wilt with seed, all alfalfa seed offered for sale is treated with a recommended fungicide. The variety **Trumpetor** shows promising resistance to wilt and should be considered for farms where wilt is present. Wilt is easily spread from field to field by machinery, on hay, or in manure. For identification of wilt contact your local crops specialist. See OMAF Factsheet, *Verticillium Wilt of Alfalfa*, Agdex 121/600.

INSECTS

Armyworm Maintain a close watch for outbreaks in grasses in late June and July. If they become destructive, control them as indicated in Disease and Insect Control in Cereal Crops section.

Cereal Leaf Beetle Refer to quarantine regulations under Insects, Cereal Crops section, concerning movement of hay.

Alfalfa Weevil Fungal disease and several species of parasites which help control the weevil are now established in Ontario. As a pest, this insect has decreased in importance across Ontario in recent years. Generally forage stands do not warrant treatment with insecticides. However farmers should check their fields carefully because populations can change from year to year. For more information on the alfalfa weevil, see Factsheet, *Alfalfa Weevil* Agdex 121/622.

The larvae cause most of the damage. They hatch from eggs deposited in the stems and crawl to the tops of alfalfa where they feed on the developing leaf and flower buds. In heavy infestations, they shred the leaves so badly that fields take on a grayish-white or frosted appearance. Experience in Ontario has shown that the peak of larval attack coincides with the bud stage of the first crop. When threatening infestations occur, fields should be cut immediately to eliminate feeding damage. This is also the best time to cut the crop for maximum yield of protein.

The key to weevil control is proper timing of harvest and treatment based on field inspection. Examine each field twice a week from mid May to June. Check several areas throughout the field. Look for damage to show up first on shallow soils or on southerly slopes.

1. **First Cut** If 25% of the stems have feeding damage in the tips, cut and remove from fields as soon as possible. If it is not possible to cut the crop immediately, treat with an insecticide as recommended in the following table.

2. **Second Cut** If damage was serious on first cut, feeding may continue and early regrowth should be carefully checked. If feeding retards regrowth, apply an insecticide.

Table 31. Alfalfa Weevil Control

Insecticide	Insecticide Formulation[1]	Product per ha	Days to Cutting or Grazing
+Furadan	480F	285mL	7
Imidan	50 WP	2.2 kg	7
Malathion[2]	500 EC	2-2.75L	7
Methoxychlor	240EC	5.5L	7
	50 WP	2.2 kg	

\+ *Minimum period before reentry into treated areas is 48 hours.See Reentry into Treated Areas.*

1 *EC (Emulsifiable Concentrate); F (Flowable); WP (Wettable Powder).*

2 *Less effective below 16°C*

CAUTION: See the warning PROTECT HONEYBEES in Disease & Insect Control in the Corn section. When planning to apply a pesticide, advise local beekeepers so that they have an opportunity to move colonies out of the danger area. Your local agricultural representative has a listing of the beekeepers in your area.

European Skipper This is an occasional but important pest of timothy, both in hay and seed production. The adult is an orange butterfly with a 2.5 cm wing spread. It congregates in damp places and skips about hay fields in mid summer. The larvae are light green caterpillars up to 2.5 cm long, usually found within rolled leaves where they feed. Leaf margins become irregularly notched and when abundant they defoliate timothy. Fields must be checked for the caterpillars by late April or early May. Initially, the small caterpillars have black heads but soon become a brown color with two light bands. If six caterpillars in an area 30 cm x 30 cm are found as early as the brown-headed stage, treat the field or the infested area. Use either Thuricide HPC at 2.25 L/ha or Dipel (SC) at 0.3-0.6 kg/ha. Note that these insecticides will not immediately kill the caterpillars. However, they will stop feeding.

Grasshoppers If grasshoppers become destructive, control them by spraying with an insecticide listed in Table 51 in the Field Peas & Field Beans Section, or with +Guthion 240SC at 1.4 L/ha.

\+ *Minimum period before reentry into treated areas is 48 hours. See Reentry into Treated Areas.*

Alfalfa Blotch Leafminer This pest of alfalfa is now present throughout Ontario. The adult leafminer is a small fly which emerges in late May. It is best identified by the numerous pinhole punctures it makes in alfalfa leaflets when it feeds and lays eggs. After the eggs hatch, the developing maggots feed inside the leaflet eating away the center part and producing mines or tunnels that terminate in blotches.

Damage to alfalfa leaves can be extensive and can result in nutritional loss and/or leaf drop. There are three generations of flies about 30 days apart. Cutting generally controls the first generation except on new seedings where an insecticide may be needed. Subsequent generations usually do not correspond to cutting dates. Insecticides effectively control this insect if applied in the "pinhole" stages in late May, early July and mid August. For early detection of damaging infestations, see Canadex Leaflet, *Early Warning System for Alfalfa Blotch Leafminer Management in Ontario*, 622.121.

Table 32. Alfalfa Blotch Leafminer Control

Insecticide	Formulation[1]	Product per ha	Minimum Days to Cutting or Grazing
Cygon	480 E	550 mL	2
+Furadan	480 F	550 mL	7
Imidan	50 WP	2.2 kg	7
Methoxychlor	240 EC	5.5 L	7
	50 WP	2.2 kg	

1 *E or EC (Emulsifiable Concentrate); F (Flowable); WP (Wettable Powder).*

\+ *Minimum period before reentry into treated areas is 48 hours. See Reentry into Treated Areas.*

Potato Leafhopper The potato leafhopper causes a substantial loss in alfalfa yield and quality some years, particularly during dry seasons when plants are under stress. Damage to direct seedings may be severe. The first cut of established fields escapes injury but as leafhoppers become more prevalent in late June to mid August, damage may be severe.

The potato leafhopper is a light green, wedge-shaped insect about 0.3 cm long when fully grown. The immature or nymph stage is yellowish-green and wingless but otherwise resembles the adult. Adult leafhoppers may jump or fly. Nymphs walk sideways or backwards to hide on the underside of the leaves.

This insect feeds by sucking plant juices. The alfalfa is stunted and the leaves turn yellow to bronze in color. A discolored V-shaped or triangular area often develops on the tips of leaflets. While this marking is characteristic of leafhopper presence, the leaf discoloration may also be a disease symptom or nutritional deficiency.

Effective control of the potato leafhopper depends on recognizing the adults and nymphs before symptoms become apparent. Check alfalfa fields frequently beginning in late June. See OMAF Factsheet, *Potato Leafhopper in Alfalfa*, Agdex 121/622. When leafhoppers are found, spray with one of the following:

Table 33. Leafhopper Control

Insecticide	Formulation[1]	Product per ha	Days to harvest
Cygon	480 E	425 mL	2
Methoxychlor	240 EC	5.5 L	7
	50 WP	2.2 kg	7

1 *E or EC (Emulsifiable Concentrate); WP (Wettable Powder).*

WEED CONTROL IN FORAGES

For weed control recommendations see OMAF Publication 75, *1984 Guide to Chemical Weed Control*.

CEREAL CROPS

Grain crops deserve to be treated as first-rate crops whenever they are included in a cropping program. They must compete for their place in that program by producing high yields economically. To produce high yields requires that all parts of the grain production package be considered. No one factor can support high yields without the others. No one factor can be neglected without a corresponding decrease in yields.

Improved varieties express their full potential only when they are used in combination with proper seeding times, seeding depth, and recommended seeding rates as well as adequate fertility applications. Indeed they perform well only when diseases, insects, and weeds are eliminated as production hazards.

Integrating the production practices into a package becomes the problem of the farmer. On his ability to do this rests the final yield and outcome of his grain production program.

VARIETY SELECTION

Variety recommendations are general guides for choosing a variety. Descriptive tables accompanying recommendations show characteristics for each variety which may limit its use. Because no variety is perfect, the recommendations should be coupled with experience and information from the description to choose a variety for your use.

Yield data, presented as tonnes per hectare (t/ha), are included to indicate the relative yield performance of recommended varieties in each of the six testing areas in Ontario. The testing areas are listed below and can be outlined by using Figure 1 (Heat Units Available for Corn Production).

Test Area I - Southwest of the 2900 heat unit line.

Test Area II - West of Frontenac, between the 2900 and 2300 heat unit lines.

Test Area III - East of Frontenac, between the 2900 and 2300 heat unit lines.

Test Area IV - The Dundalk plains (Grey, Dufferin and Wellington) within the 2500 heat unit line.

Test Area V - Northern Ontario between the 2300 and 1900 heat unit lines.

Test Area VI - Northern Ontario - North of the 1900 heat unit line.

Variety recommendations for grains to be stored and used as high moisture grains and whole plant silages are the same as those to be used for normal grain storage and use.

SPRING GRAINS

Planting date All spring grains respond with higher yields to early seeding. Because cool moist conditions in the spring promote ample tillering and large heads, plant as early as soil conditions permit. The target date should be April 10 for southwestern Ontario, and April 15 for central and eastern Ontario. Planting delays beyond April 20-25 generally result in a yield reduction of 50 kg/ha for each day delayed. **Perth, Mingo, Bruce** and **Leger** barley and **Elgin** and **Oxford** oats do not show as great a yield reduction with late planting as do other spring cereal varieties. These varieties should be considered for circumstances where late planting cannot be avoided.

Planting rate Spring cereal seeding rate recommendations can be found under Seeding Rates in the General section. The highest seeding rates should be used where growing conditions are unfavorable or in late planting situations.

Milling Oats Milling oats have to meet special quality requirements: plump kernels, high hectoliter weight and groats that are free of discoloration. All varieties recommended for Ontario can be used to produce milling oats.

Table 34. Recommended Barley Varieties

Variety	Area Recommended	Type and Maturity	Height	Lodging Resistance	Reaction to Disease[1]		
					Loose Smut	Spot Blotch	Mildew
2-Rowed							
Birka	All areas	Rough-awned late	Short	Good	MR	S	R
Herta	All areas	Rough-awned late	Medium to short	Medium	MR	S	R
Rodeo	All areas	Rough-awned	Short midseason	Good	MR	S	R
6-Rowed							
Bonanza[2]	Area V	Smooth-awned midseason	Medium	Medium to good	R	S	S
Bruce	All areas	Rough-awned early	Medium to short	Medium to good	MS	T	R
Leger[3]	All areas	Smooth-awned midseason	Medium	Medium	R	S	MR
Massey[2]	All areas	Smooth-awned midseason	Medium	Medium	R	S	R
Mingo	All areas except VI	Smooth-awned midseason	Medium	Medium	MS	S	MS
Pequis[2]	Areas V and VI	Smooth-awned midseason	Medium	Medium	R	S	R
Perth	All areas where lodging is a problem	Smooth-awned midseason	Medium	Very good	R	T	R

1 *See Disease and Insect Control in Cereal Crops. R (Resistant); MR (Moderately resistant); MS (Moderately susceptible); S (Susceptible); T (Tolerant). R indicates resistance to prevalent races only and may not indicate resistance to new races of the disease organism; because of this all varieties should be seed treated with Vitaflo 280 to control loose smut. T indicates that plants become infected but do not suffer significant yield loss.*

2 *Bonanza Massey and Pequis may be removed from the recommended list in 1985 because of availability of superior varieties.*

3 *Seed supplies of Leger are limited for 1984.*

MIXED GRAINS

Mixed grains occupy a large hectareage in the province. No specific recommendations regarding the best mixtures can be made. Generally the highest yielding varieties of oats and barley in pure stands also perform best in mixtures.

Height and maturity ratings of the components of a mixture must be matched. For example, Donald oats mix well with Leger barley, and Elgin oats mix well with Bruce barley.

An advantage of mixed grains is that leaf and head diseases usually are much less severe than where oats or barley are grown alone.

SPRING WHEAT

Spring wheat is not generally grown in Ontario. In areas III, V, and VI, however, it can be competitive with oats and barley as a feed grain. For those farmers who choose to grow spring wheat for feed, the variety **Glenlea** is available.

Glenlea - awnless, white chaff large red grain. Utility grain wheat not equal in milling quality to hard red spring types.

SPRING TRITICALE

Spring triticale is not generally grown in Ontario as it is later maturing than the other spring cereals. For those farmers who choose to grow spring triticale for feed, the variety **OAC Triwell** is available. It is a rough-awned, white-chaffed variety with good standability and good resistance to powdery mildew and leaf rust. If stands are thin or the crop is stressed around flowering, ergot contamination of the grain can be a problem.

Table 35. Barley Variety Yields[1] - Tonne/Hectare[2]

Variety	Test Areas					
	I (10)[3]	II (26)	III (8)	IV (5)	V (5)	VI (4)
Birka	3.3	3.5	4.0	3.0	3.7	4.1
Herta	3.4	3.6	3.8	3.1	3.4	4.1
Rodeo	3.4	3.5	4.0	3.0	3.8	4.4
Bonanza	3.1	3.4	3.6	2.8	3.8	4.1
Bruce	3.2	3.6	3.6	3.0	3.8	4.4
Leger	3.6	3.8	4.2	3.1	4.1	4.8
Massey	3.3	3.5	3.9	2.7	3.6	4.2
Mingo	3.3	3.7	4.2	3.1	3.9	3.9
Peguis	3.2	3.4	3.8	2.9	3.9	4.4
Perth	3.1	3.3	3.3	2.6	3.5	3.9

1 *two-year average (1982-1983)*

2 *1 t/ha = 893 lb/ac*

3 *Number of tests*

Table 36. Recommended Oat Varieties

Variety	Area Recommended	Seed Size	Height	Lodging Resistance	Maturity	Reaction to Disease[1] Leaf Rust
Donald	All areas	Very large	Medium	Medium	Early to midseason	S
Elgin	All areas	Large	Short	Good	Early to midseason	S
OAC Woodstock	All areas	Large	Medium	Medium to good	Midseason to late	R
Oxford	All areas	Medium (yellow)	Medium	Very good	Midseason to late	MS
Sentinel[2]	All areas	Medium to large	Medium	Good	Midseason to late	S

1 *See Disease and Insect Control in Cereal Crops*
R (Resistant); MS (Moderately Susceptible); S (Susceptible)

2 *Sentinel may be removed from the recommended list in 1985 because of availability of superior varieties.*

Table 37. Oat Variety Yields[1] - Tonne/Hectare[2]

Variety	Test Areas I (28)[3]	II (59)	III (18)	IV (14)	V (10)	VI (7)
Donald	3.3	3.5	3.3	3.5	3.8	3.8
Elgin	3.2	3.3	3.3	3.0	3.5	3.5
OAC Woodstock	3.1	3.6	4.0	3.6	3.4	4.2
Oxford	3.3	3.4	3.6	2.9	3.8	4.1
Sentinel	3.2	3.1	3.5	3.0	4.2	4.7

1 *Two-year average (1982-1983)*

2 *1 t/ha = 893 lb/ac*

3 *Number of tests*

WINTER GRAINS

For good winter survival, seed early enough to obtain adequate top growth and root development in the autumn. This is particularly important for winter barley. Winter cereal seeding rate recommendations can be found under Seeding Rates in the General section.

WINTER WHEAT

Soft White Winter Wheat. Soft white winter wheat has long been the dominant winter grain of Ontario. Markets are well established, and varieties well adapted to Ontario conditions are available (Table 38). It should be the first choice for farmers wishing to grow a cash crop winter cereal.

Hard Red Winter Wheat. Hard red winter wheat is now grown in Ontario. It cannot yet be recommended because markets are not well established, and available varieties (predominantly **Maxopol**) have not been widely tested for adaptability to local conditions. The quality of the hard red winter wheat is very different from that of the traditional soft white varieties. Because of this, the two types should be kept separate throughout the production and marketing channels. Mixed lots will only find a use as livestock feed, and will thus realise a lower price than unmixed lots of white wheat of milling grade.

WINTER TRITICALE The only winter triticale variety licensed for sale in Ontario is **OAC Wintri.** It has better winter survival compared to the recommended winter wheat varieties. It is resistant to mildew and rust and incidence of ergot infection is very low. OAC Wintri is very tall, later maturing than Fredrick, and has poor lodging resistance, especially on heavier soils. High levels of nitrogen fertilization can result in lodging problems with yield losses. The test weight is 10% to 20% below wheat. OAC Wintri is a feed grain which is adapted to areas of Ontario where winter injury makes winter wheat production risky.

WINTER BARLEY Winter barley has higher yield than spring barley but is considerably less winterhardy than winter wheat. It can be expected to survive only in areas south of the 2700 heat unit line. Winter barley matures much earlier than winter wheat and if harvested as a silage crop is suitable for double cropping. For farmers who choose to grow winter barley the variety and **OAC Halton** is available. OAC Halton is a six-rowed, rough awned variety with short straw and very good lodging resistance. It is resistant to mildew and leaf rust.

Table 38. Recommended Winter Wheat Varieties

Variety	Area Recommended	Lodging Resistance	Height[1] (cm)	Reaction to Disease[2] Leaf Rust
Augusta	I, II, III	Medium to good	100-110	MS
Favor[5]	II[4]	Medium to poor	105-115	S
Frankenmuth	I, II[3], III[3]	Medium	100-110	S
Fredrick	I, II[3], III[3]	Medium to good	110-120	MS
Gordon	III[4]	Poor	100-110	S
Houser	I[4],II[4],III[4]	Medium	95-100	S

Winter Survival: All recommended winter wheat varieties have similar winter survival

1 *The figures indicate the range generally found in the province.*

2 *See Disease and Insect control in Cereal Crops. MS (moderately susceptible); S (susceptible).*

All varieties should be seed treated to control loose smut. For further information see OMAF Factsheet, Winter Wheat in Ontario, Agdex, 112/10.

3 *Only where test weight and lodging are problems with other varieties.*

4 *Not on light droughty soils and other locations where low test weight is a problem.*

5 *Favor may be removed from the recommended list in 1985.*

Table 39. Winter Wheat Variety Yields and Test Weights [1]

Variety	Yields (tonne/ha)[2] Test Areas I (22)[4]	II (22)	III (5)	Test Weights (kg/hL)[3] Test Areas I (25)	II (19)	III (4)
Augusta	4.9	4.7	4.9	73	73	76
Favor	4.6	4.4	4.5	71	73	75
Frankenmuth	4.8	4.5	4.6	75	75	78
Fredrick	4.7	4.4	4.5	77	76	79
Gordon	4.5	4.3	5.1	71	71	75
Houser	4.7	4.7	4.8	70	71	75

1 *Four year average (1980-83)*

2 *1 t/ha = 893 lb/ac*

3 *kg/hL x .801 = lb/bu*

4 *Number of tests*

Table 40. Distributors for Cereal Grain Varieties

	Variety	Distributor[1]
Barley	Birka	W.G. Thompson & Sons Ltd.
	Bonanza	public
	Bruce	SeCan
	Herta	public
	Leger	SeCan
	Massey	SeCan
	Mingo	Stewart Seeds
	Peguis	public
	Perth	King Grain Limited
	Rodeo	Stewart Seeds
Oats	Donald	SeCan
	Elgin	public
	OAC Woodstock	SeCan
	Oxford	Stewart Seeds
	Sentinel	SeCan
Spring Triticale	OAC Triwell	Speare Seeds Ltd.
Spring Wheat	Glenlea	public
Winter Barley	OAC Halton	SeCan
Winter Triticale	OAC Wintri	King Grain Limited
Winter Wheat	Augusta	W.G. Thompson & Sons Ltd.
	Favor	Stewart Seeds
	Frankenmuth	King Grain Ltd.
	Fredrick	public
	Gordon	SeCan
	Houser	W.G. Thompson & Sons Ltd.

1 *See Distributor Addresses in General section.*

FERTILIZERS FOR CEREAL CROPS

Fertilizer requirements for cereals in Ontario can best be estimated by using a soil test along with information on the species grown and past management such as manure. Fertilizer recommendations are based on the results of trials run on research stations and farm fields in Ontario. The recommendations in this publication can be expected to produce highest economic returns from the crop when good or above average management is used.

To provide dependable fertilizer recommendations each field should be tested at least once every third year. When large amounts of nutrients are removed from sandy soils (with crops such as hay, corn, silage, potatoes or tomatoes) and manure is not applied, annual testing is advisable as potash soil tests can change rapidly under these conditions.

Where a soil test is not available, a rough estimate of requirements can be obtained from Tables 43 and 44 using the following guidelines:

a. Where the field has been fertilized regularly for a number of years or heavily in recent years, use one of the rates of phosphate and potash recommended for a MEDIUM soil test rating (see Tables 42 and 43).

b. If the field has received little fertilizer in the past, use one of the rates recommended for a LOW soil test rating (see Tables 42 and 43).

Some clay and clay loam soils are naturally high in potassium and do not require any potash fertilizer. Only a soil test can adequately determine potash requirements.

Nitrogen

No soil test is available which is satisfactory for nitrogen under Ontario conditions. Nitrogen fertilizer recommendations for cereal crops are, therefore, based on the crop and on the region of the province and adjusted downward if manure is applied or if the previous crop contained perennial legumes such as alfalfa (see Tables 62, 63 and 64). High rates of nitrogen from manures or manufactured fertilizers can cause lodging of cereals.

Table 41. Nitrogen Requirements - Cereal Crops

Crops	N required[1] kg/ha
Oats, buckwheat, millet, spring rye (southern Ontario)	35
Oats, buckwheat, millet, spring rye (northern Ontario)[2]	55
Barley, mixed grain, spring wheat and triticale, flax, fodder rape, kale, sunflower (southern Ontario)	45
Barley, mixed grain, spring wheat and triticale, flax, fodder rape, kale, sunflower (northern Ontario)[2]	70
Cereals seeded as a nurse crop for forages	15
Winter Triticale	80[3,4]
Winter wheat, winter barley, winter rye	90[3,4]

100 kg/ha = 90 lb/ac

1 *Where manure is applied or the preceding crop is a legume sod, reduce the nitrogen rates as shown in Tables 62, 63 and 64.*

2 *Northern Ontario refers to Algoma, Cochrane, Kenora, Manitoulin, Nipissing, Rainy River, Sudbury, Temiskaming and Thunder Bay districts.*

3 *0 to 10 kg nitrogen per hectare at seeding, 90 to 80 kg nitrogen per hectare in April.*

4 *When not in rotation with tobacco.*

Phosphate and Potash

Phosphate and potash requirements for cereals are presented in Tables 42 and 43. These recommendations are based on soil tests conducted in the Ontario Ministry of Agriculture and Food soil testing laboratory at the Department of Land Resource Science, University of Guelph. These tables should not be used with soil test readings from other soil testing laboratories unless the methods used are identical to those used in the OMAF laboratory.

Micronutrients

Manganese deficiency occurs occasionally on cereals in Ontario. Copper deficiency may occur on organic soils and is suspected in rare occasions on very sandy soils. Boron deficiency has not been diagnosed on cereals and boron applications can be toxic. Zinc deficiency on cereals does not appear to be a problem.

Manganese deficiency frequently occurs when wheat, oats and barley are grown on an organic soil. It can occasionally occur on mineral soils high in organic matter and on very sandy soils. On oats, manganese deficiency appears as irregular oval gray spots on the leaves. On barley and wheat, it appears more commonly as a light yellow color on the leaves with the veins in the leaf remaining slightly darker green. In addition to deficiency symptoms on leaves, both soil tests and plant analyses are useful in predicting where manganese deficiencies are likely to occur. Both are available at the OMAF soil testing and plant analysis laboratory. Correct the deficiency as soon as detected by spraying the foliage with 2 kg manganese/ha from manganese sulfate (8 kg manganese sulfate/ha) or 0.4 kg/ha of manganese in chelated form in 200 L of water.

Use a "spreader sticker" in the spray. If the deficiency is severe a second spray may be beneficial.

Soil application is not a good way to apply manganese regardless of source because of the large amounts required.

Mixtures of herbicides and foliar fertilizers should not be applied to crop foliage unless recommended by competent authorities.

For further details on manganese deficiencies and on methods of application, refer to OMAF Factsheet, *Manganese in Soybeans and Small Grain Production*, Agdex 100/531.

Methods of Application

Where phosphate fertilizer is required for cereal crops it is best drilled with the seed and may be accompanied by some or all of the required nitrogen and potash, depending on rates of application.

For spring seeded cereals on sands and sandy loam soils, rates of fertilizer applied with the seed should not exceed 35 kg of nitrogen or 55 kg (nitrogen + potash) per hectare. On loam, silt loam and clay loam soils, rates with the seed should not exceed 45 kg nitrogen or 65 kg (nitrogen + potash) per hectare. No more than 10 kg urea nitrogen per hectare should be applied with the seed. If urea supplies part of the nitrogen in a fertilizer applied with the seed no more than 20 kg total nitrogen per hectare should be applied. For fall seeded cereals rates of fertilizer with the seed should not exceed 15 kg nitrogen or 35 kg (nitrogen + potash) per hectare. The application of fertilizers containing diammonium phosphate (18-46-0) or urea in a seed drill with fall seeded cereals is not recommended because it can cause root damage and reduce yields.

Table 42. Phosphate Requirements for Cereals Based on OMAF Soil Tests

Phosphorus Soil Test	Spring barley and mixed grain: Rating	Phosphate (P_2O_5)[1] Required kg/ha	Oats, spring wheat, spring triticale, spring rye, fodder rape, canola, kale, flax, and buckwheat: Rating	Phosphate (P_2O_5)[1] Required kg/ha	Winter wheat, W. rye, W. barley, W. triticale: Rating	Phosphate (P_2O_5)[1] Required kg/ha	Winter or spring grains seeded down: Rating	Phosphate (P_2O_5)[1] Required kg/ha
0 - 3		110		70		70		130
4 - 5		100		60		60		110
6 - 7	LOW	90	LOW	50	LOW	50	LOW	90
8 - 9		70		30		30		70
10 - 12		50		20		20		50
13 - 15	MEDIUM	20	MEDIUM	20	MEDIUM	20	MEDIUM	30
16 - 20		20		0		20		20
21 - 25		0	HIGH	0		0		20
26 - 30	HIGH	0		0	HIGH	0		0
31 - 40		0		0		0	HIGH	0
41 - 50	VERY HIGH	0	VERY HIGH	0	VERY HIGH	0	VERY HIGH	0
51 - 60		0		0		0		0
61+	EXCESSIVE[2]	0	EXCESSIVE[2]	0	EXCESSIVE[2]	0	EXCESSIVE[2]	0

100 kg/ha = 90 lb/ac

1 *Where manure is applied reduce the fertilizer application according to the amount and quality of manure (see Manure in soils section). For spring barley in southern Ontario not manured and not following a legume sod, the nitrogen requirement is 45 kg/ha (see Table 42). If the soil tests are 11 for phosphorus and 48 for potassium the phosphate requirement would be 50 kg/ha and the potash requirement 50 kg/ha. These nutrients could be supplied by drilling 250 kg (50 ÷ 20 x 100) of 5-20-20 per hectare to supply the phosphate and potash and broadcasting 100 kg of 34-0-0 or 75 kg of 45-0-0 per hectare to supply the recommended amount of nitrogen.*

2 *Excessive readings may cause reduced yield or affect nutrient balance in crops and increase the risk of water pollution.*

Table 43. Potash Requirements for Cereals Based on OMAF Soil Tests

	Spring barley and mixed grain		Oats, spring wheat, spring triticale, spring rye, fodder rape, kale, flax, buckwheat		Winter wheat, W. rye, W. barley, W. triticale with or without seeding down		Spring cereals seeded down	
Potassium Soil Test	Rating	Potash (K_2O)[1] Required kg/ha	Rating	Potash (K_2O)[1] Required kg/ha	Rating	Potash (K_2O)[1] Required kg/ha	Rating	Potash (K_2O)[1] Required kg/ha
0 - 15		90		70		50		90
16 - 30		80		50		40		80
31 - 45	LOW	70	LOW	40	LOW	30	LOW	70
46 - 60		50		30		20		50
61 - 80		40	MEDIUM	20		20		40
81 - 100		30		20	MEDIUM	20		30
101 - 120	MEDIUM	20	HIGH	0	HIGH	0	MEDIUM	20
121 - 150		20		0		0		20
151 - 180	HIGH	0		0		0	HIGH	0
181 - 210		0	VERY HIGH	0	VERY HIGH	0		0
211 - 250	VERY HIGH	0		0		0	VERY HIGH	0
251+	EXCESSIVE[2]	0	EXCESSIVE[2]	0	EXCESSIVE[2]	0	EXCESSIVE[2]	0

100 kg/ha = 90 lb/ac

1 *Where manure is applied reduce the fertilizer application according to the amount and quality of manure (see Manure in Soils section).*

2 *Excessive ratings may cause reduced yield or quality of crops primarily due to magnesium deficiency. Natural levels above 250 occur occasionally on clay and clay loam soils but are not expected to cause problems because soils naturally high in potassium are usually high in magnesium.*

SEED TREATMENTS

Following cleaning, all cereal seed should be treated with a seed treatment. Good coverage of the seed is essential. Follow the precautions under Seed Treatments in General Information on Pesticide Usage section, when applying any chemical seed treatment.

Seed treatments control certain soil and seed-borne cereal diseases. The recommended seed treatments and diseases controlled are given in Table 44.

DISEASES

See OMAF Factsheets, *Leaf and Head Diseases of Barley*, Agdex 114/632; *Leaf Diseases of Winter Wheat*, Agdex 112/600; *Head Diseases of Winter Wheat*, Agdex 112/630.

Loose Smut of Barley Sow pedigreed seed of a resistant variety. However, these varieties are resistant ONLY to the prevalent races of smut fungus and may not resist other races. It is STRONGLY RECOMMENDED that ALL BARLEY SEED BE TREATED WITH VITAFLO-280 or a drillbox formulation containing Vitavax.

Loose Smut of Wheat Sow pedigreed seed. VITAFLO-280 which contains carbathiin for smut control and thiram for control of seedling blight is recommended for wheat grown for food or feed. All wheat grown for seed should be treated with VITAFLO-250. VITAFLO-250 contains more carbathiin than VITAFLO-280 and controls smut more effectively.

Dwarf Bunt of Wheat None of the registered seed treatments control dwarf bunt effectively. The bunt fungus remains infective for several years in the soil. Some control can be achieved by growing any other crop, including oats and barley, over a period of years on infested land.

Fusarium Head Blight (Scab) occurs mainly in wheat. Outbreaks occur when the weather is warm and wet at the flowering to soft-dough stages. Vomitoxin may be present in diseased heads. See OMAF Factsheets, *Head Diseases of Winter Wheat*, Agdex 112/630 and *Moldy Feeds and Swine Diseases*, Agdex 440/60. Head blight is usually more severe when wheat follows wheat, corn or triticale. Plow down infested stubble and straw.

Foot Rot (Eyespot, Strawbreaker) and **Take All** in wheat are often damaging especially when wheat follows wheat. Avoid early planting. Plow down wheat stubble deeply. Include crops such as soybeans, field beans, clovers, alfalfa or oats in the rotation.

Spot Blotch, Seedling Blight, Root Rot and Head Blight are often serious and widespread in barley and are caused by the same fungus Bipolaris (Helminthosporium, Cochliobolus). The fungus overwinters in seed, barley debris and soil. All barley seed should be treated with the fungicide Vitaflo 280 to control the fungus inside the seed and that which invades seedlings from the soil. To reduce severity of spot blotch and head blight, avoid growing barley after barley, wheat and grasses. Early planting helps to avoid serious disease in late July. Disease is less severe on barley grown in mixtures with oats. Perth and Bruce barley show some disease resistance.

Net Blotch and Scald occur mainly in winter barley but sometimes in spring barley, and especially in cool, humid seasons. **OAC Halton** is moderately resistant to both diseases. Two-rowed barleys usually are more susceptible to net blotch than are 6-rowed barleys. Massey is resistant to scald. To help prevent buildup of these diseases, avoid growing barley after barley, plow down stubble and straw as completely as possible, and treat seed with Vitaflo.

Septoria Leaf Blotch in oats can cause severe damage in all recommended varieties. The disease is recognized by the appearance of mottled, light and dark brown, elongate blotches on the leaf blade, extending to the leaf sheath and culm. Advanced stages on the culm turn black and the weakened culm breaks over easily resulting in damage due to lodging. Avoid planting oats after oats or mixed grains.

Snow Mold on winter wheat. In years when snow mold causes great reductions in stands, reseed as soon as possible with a spring grain. This disease does not affect spring-planted grain.

Powdery Mildew is favored by warm, humid weather. For **barley**, use resistant cultivars in areas where powdery mildew is common.

Cereal Rusts Stem rust of cereals and leaf rust of oats are often serious especially in Central and Eastern Ontario. The common barberry is the source of the stem rust fungus and the European buckthorn is the source of the oat leaf rust fungus.

Common barberry is a 2- to 3- m shrub with three-pronged spines on the stems, sawtoothed edges on the leaves, and oblong red berries which hang on the plant through the fall and winter.

European buckthorn is a shrub or small tree with dark green leaves and round black berries. The leaves hang on until late in the fall and the berries remain most of the winter.

When stem rust is a problem destroy all common barberry on your farm. When oat leaf rust is a problem destroy all European buckthorn on your farm. In both instances also contact your Area Weed Inspector and Ministry of Agriculture and Food office and request that areas surrounding your farm be checked and common barberry or European buckthorn destroyed. Consult OMAF Publication 49, *Rid Ontario of Common Barberry and European Buckthorn*.

The oat variety **OAC Woodstock** is resistant to present races of oat leaf rust.

Ergot occurs from time to time on barley and triticale. Exercise caution in feeding grain containing the black ergot bodies to livestock, especially swine. Do not sow seed containing ergot.

Barley Yellow Dwarf or Oat Red Leaf This disease was unusually severe in 1959 and 1976. It is unlikely to be severe unless warm weather and southerly winds occur in April. Direct control by spraying the aphids which carry the virus is unlikely to be useful. Early seeding is an advantage in spring grains. Winter wheat also is susceptible to barley yellow dwarf. Late planting helps to avoid infection in the fall. See OMAF Factsheet, *Cereal Virus Diseases*, Agdex 110/632).

Oat Cyst Nematode Damage by the oat cyst nematode is first noticed about two or three weeks after oat plants emerge, at which time heavily infected plants appear to suddenly stop growing, leaves turn pale in color and begin to die back from the tips downward. These plants fail to tiller resulting in a thin stand of stunted plants which produce little grain. Below ground the root systems are severely stunted and usually discolored, from a pale-yellow in early growth to a yellow-brown in mature plants, as compared to the clear white in healthy plants.

To confirm suspected oat cyst nematode damage, dig up affected plants at early heading stage. Carefully wash soil from the roots by dunking in a pail of water, then examine the roots for presence of young cysts. These appear as tiny, pearl-like objects adhering to the young roots. If still in doubt, send a sample of several plants with adhering soil to the Pest Diagnostic Clinic, Department of Environmental Biology, University of Guelph, Ontario, N1G 2W1 for diagnosis.

Continued on Page 53

Table 44. Cereal Seed Treatments

Product	Active Ingredient	Formulation[2]	Diseases: Oats - covered smut	Oats - loose smut	Barley - covered smut	Barley - loose smut	Barley - seedling blight	Wheat - common bunt	Wheat - dwarf bunt	Wheat - loose smut	Wheat - seedling blight	Rye - seedling b. ght
Agrox N-M	maneb	P-DB	+	+	+	-	-	+	-	-	+	+
Agrox flowable	maneb	S	+	+	+	-	-	+	-	-	+	+
Busan 30	TCMTB	EC	+	+	+	-	-	+	-	-	+	+
Co-op N-M	maneb	P-DB	+	+	+	-	-	+	-	-	+	+
Polyram Liquid	metiram	S	+	+	+	-	-	+	-	-	+	+
Polyram	metiram	P-DB	+	+	+	-	-	+	-	-	+	+
[1]Vitaflo-250	carbathiin	S	+	+	+	+	+[4]	+	-	+	-	-
[1]Vitaflo-280	carbathiin + thiram	S	+	+	+	+	+	+	-	+[5]	+	+
[1]Vitavax Powder	carbathiin + thiram	P-DB	+	+	+	+	+	+	-	+[5]	+	+
Seed treatments with insecticides[3]												
Mergamma N-M	maneb + lindane	P-DB	+	+	+	-	-	+	-	-	+	+
Co-op N-M Dual Purpose	maneb + lindane	P-DB	+	+	+	-	-	+	-	-	+	+
[1]Vitaflo Dual Purpose	carbathiin + thiram + lindane	S	+	+	+	+	+	+	-	+[5]	+	+
Vitavax Dual Powder	carbathiin + thiram + lindane	P-DB	+	+	+	+	+	+	-	+[5]	+	+

1 *Read the paragraph on seed treatments, and also the sections Loose Smut of Barley, Loose Smut of Wheat.*

2 *EC (Emulsifiable Concentrate); P-DB (Powder Drill Box); S (Flowable Suspension).*

3 *See Precautions with Pesticides section.*

4 *Reduces Bipolaris (Helminthosporium) seedling blight but may not control other seedling blights and seed decay.*

5 *Where loose smut in wheat is a problem, use Vitaflo-250 which contains more active carbathiin than Vitaflo-280.*

\+ *Recommended for disease listed;* - *NOT recommended.*

Oat Cyst Nematode **(Cont'd. from Page 51)**

If oat cyst nematodes have caused damage do not plant spring grains the following year. Use legume or row crops in the rotation. Corn can be used if the nematode population is low but will suffer damage if the soil is heavily infested. The nematode invades corn roots but does not reproduce in them; thus consecutive cropping to corn effectively reduces the population of oat cyst nematodes.

For additional information, see OMAF Factsheet, *Oat-Cyst Nematode*, Agdex 113/632.

INSECTS

Wireworms damage cereal crops in certain areas every year. Injury is usually most severe in the two years following grass sod. As a precautionary measure, use a drill-box formulation containing lindane (see Table 44). Use a wooden paddle to mix the chemical with the seed. Do not breathe the dust stirred up during mixing, wear rubber gloves and a respirator. Follow the precautions in Precautions with Pesticides section when using seed treatments.

Armyworms are brown to dark green caterpillars with five longitudinal stripes on their bodies. They are 4 cm long when fully grown. They appear in damaging numbers at intervals of about 10 years except for localized infestations which may appear at any time. The caterpillars appear in grain crops during late June to mid July depending upon geographical location. They can best be detected by examining crops frequently during early evening just before sunset; at this time the caterpillars are moving up on the plants to feed. They hide under clumps of grass and clods of dirt during the day. **Five to six larvae in an area 30 by 30 cm warrant chemical control.**

If foliage is heavily notched and most of the caterpillars are less than 4 cm long, treat immediately. When plants are completely defoliated and most caterpillars are fully grown, treatment is not practical. Each field must be assessed and dealt with separately. Armyworms often move in large numbers from one field to another. When this happens it is advisable to spray the border of the invaded field. There is no benefit in applying a control measure when the armyworm is nearly full grown, the pupae present, feeding extensive or the crop near "maturity". By this time most of the damage will have been done.

Malathion is less effective below 16°C. Where less than 60 L of spray are used per hectare, Lannate provides better control than the other insecticides.

Table 45. Armyworm Control

Insecticide	Formulation[1]	Product/ha	Days to Harvest
Dylox	80% SP	700 g	21
	420 Liquid	1.5 L	
+Lannate	Liquid	2.3 L	20
Malathion	500 EC	2.8 L	7
Methoxychlor	240 EC	10.0 L	7
Sevin XLR[2]	480 Su	2.5 - 5.25 L	20

1 *EC (Emulsifiable Concentrate); SP (Soluble Powder); Su (Suspension)*

2 *Several formulations of Sevin are available for use according to label instructions. Sevin XLR is recommended because it is less hazardous to bees. Follow precautions applying to honeybees. See Protect Honeybees section.*

\+ *Minimum period before reentry is 24 hours.*

Insecticides listed in order of preference.

Bee Poisoning

During the past several years spraying for armyworms, especially with Sevin, has resulted in heavy bee kills. **This must be avoided.** Treat only when needed. Use an insecticide other than Sevin if bees are in the area. Avoid contamination of areas where weeds are in bloom. Do not spray when the wind is blowing. Treat in the late evening. If spraying by aircraft, avoid spraying close to roadsides and adjacent fields where plants are in bloom. Advise local beekeepers of your spraying activities. Your local agricultural representative has a list of beekeepers in your area.

Cereal Leaf Beetle is a metallic blue-green beetle 0.5 cm in length, with reddish-orange head and legs. The larva is slug-like in appearance, 0.6 cm in length when mature and yellowish in color, but its true color is obscured by a black deposit of fecal material. Eggs are pinhead in size, elongate and bright-yellow to dull brown in color located along the mid vein on the upper surface of the leaf.

Both the adults and larvae cause damage by chewing long strips of tissue between the leaf veins. However, most of this injury is done by the larvae in June. Heavily damaged fields take on a silvery appearance.

An effective parasite is now established throughout Ontario, which generally controls the cereal leaf beetle. However, if the cereal leaf beetle is of concern on your farm, please notify the Ontario Ministry of Agriculture and Food.

Quarantine Regulations A quarantine is in effect to prevent the spread of this insect to western Canada. Growers contemplating selling baled hay or straw to western Canada should contact the local office of the Food Production and Inspection Branch of Agriculture Canada.

Grasshoppers If they become destructive control them as indicated in the Field Bean section.

Aphids. Aphids are often found on cereals but are seldom numerous enough to cause reduced yields. Immigrant aphids carry yellow dwarf virus. Unfortunately it is not possible to kill the aphids efficiently enough to prevent disease transmission to cereals.

INSECTS IN FARM STORED GRAIN

Insects are a major problem in farm stored grain in Ontario. Ontario producers sustain considerable losses annually. In some instances, shipments to elevators are refused because of insects.

The Key to Control of insects in stored grain is prevention through good sanitation and storage. The following are essential:

1. Clean up all spills of grain and feed. Such spilled material usually becomes infested and is a major source of insect problems. All residue grain that is removed should either be burned, deposited in a sanitary fill or ground up for feed.

2. Bins and equipment must be thoroughly cleaned before storing grain. This means cleaning out all caked material. **Use a good vacuum cleaner.** Such cleaning removes old grain that may be infested with insects that would spread to the new grain. In particular check:

- corners and cracks
- behind partitions
- between double walls
- outside and under bins

- grain handling equipment
- aeration piping
- perforated floors.

There is a major problem with fully perforated floors. They cannot be lifted for cleaning and they get clogged and infested. This is an engineering problem and fumigation is costly and not always effective.

3. It is obvious that new grain must never be stored with old because any insects will spread from the old grain to the new.

4. After clean up, repair storage facilities so that they are pest-proof.

5. Any remaining insects that would infest the grain can be killed by spraying the empty bins. Use 250-330 mL of malathion 500 EC in 5L of water. This will treat 100 m^2 of bin surface. **Treat bins two weeks before grain storage.** Sprays are not a substitute for a thorough and complete clean-up. If bin surfaces are dusty or covered with caked material the spray will not penetrate or adhere to kill crawling insects.

6. Leave space between feed rooms and storage facilities because feed rooms are difficult to keep free of pests and insects can quickly spread to nearby storage facilities. For the same reason grain should not be stored in buildings that shelter animals or hay because mangers, feed boxes and troughs are often insect-infested. In addition, such buildings are warmer and thus insects can remain active throughout winter.

7. Molds, as well as insects are much more troublesome in moist grain. If stored grain has more than 14% moisture check it regularly.

8. Using aeration to cool down grain in the fall will reduce insect infestations. Insects do not develop in grain with temperatures below 18° C. Best grain temperature for long term storage is 5°C to 10°C.

The above program of sanitation and pest proofing usually prevents pest problems. However, inspect and sample grain regularly. Should an insect problem develop in storage, seek OMAF Publication 229, *Insects in Farm Stored Grain*, for recommendations on fumigating. Agriculture Canada Publication 1595, *Insects and Mites in Farm Stored Grain in the Prairie Provinces* is also useful.

Precautions

When handling fumigants follow the safety directions given on the manufactured product. Always work in pairs. Wear the recommended gas mask. Remove livestock or poultry that are in the same building, especially if they are under the grain bin.

Some people experience allergic reactions to grain dust and/or molds. Dust masks or respirators will help prevent this when handling grain.

WEED CONTROL IN CEREAL CROPS

For weed control recommendations see OMAF Publication 75: *1984 Guide to Chemical Weed Control*

FIELD BEANS AND FIELD PEAS

FIELD BEANS

CROP MANAGEMENT

In both white beans and kidney beans, row widths of 60-70 cm are standard due to the nature of the harvesting equipment. For white beans plant 16 to 20 seeds/metre of row (40 to 45 kg/ha). For kidney beans, a seeding rate of 10 seeds per metre (67 kg/ha) is recommended. These seeding rates should result in the highest yield with a minimum of disease problems.

In areas of 2600 to 2900 heat units white beans should be planted between May 20 and June 10. In areas with greater than 2900 heat units, planting should occur between June 5th and 20th.

Kidney beans are normally planted during the first 10 days of June. Planting at this time permits the crop to mature during mid-September when adequate harvest conditions are likely to exist.

FIELD PEAS

VARIETY RECOMMENDATIONS

Century Areas north of 2900-heat-unit line, (see Heat Units Available for Corn Production, Figure 1). Seed is medium size, smooth and rounded, yellow; used for soup, either whole or split. Flowers are white; matures midseason.

Trapper areas north of the 2900-heat-unit line, (see Heat Units Available for Corn Production, Figure 1). Seed is small size, smooth and rounded, yellow; matures five days earlier than Century.

FERTILIZERS FOR FIELD BEANS AND PEAS

Fertilizer requirements for beans and peas in Ontario can best be estimated by using a soil test along with information on past management such as manure. Fertilizer recommendations are based on the results of trials run on research stations and farm fields in Ontario. The recommendations in this publication can be expected to produce the highest economic returns from the crop when good or above average management is used.

To provide dependable fertilizer recommendations each field should be tested at least once every third year. When large amounts of nutrients are removed from sandy soils (e.g. with crops such as hay, corn silage, potatoes, tomatoes), annual testing is advisable as potash soil tests can change rapidly under those conditions.

Where a soil test is not available a rough estimate of fertilizer requirements can be obtained from the accompanying table using the following guidelines:

a. Where the field has been fertilized regularly for a number of years or heavily in recent years, use one of the rates of phosphate and potash recommended for the MEDIUM soil test rating (see Table 47);

b. If the field has received little fertilizer in the past, use one of the rates recommended for LOW soil test rating (see Table 47). Some clay and clay loam soils are naturally high in potassium and do not require any potash fertilizer. Only a soil test can adequately determine potash requirements.

Table 46. Field Bean Variety Recommendations

Variety	Heat Unit Rating	Yield[1] t/ha	Days to Maturity	1000 Seed Wt[1] (g)	Disease Reaction[2]		
					White mould Infection (%)	Bean Common Mosaic Virus	Anthracnose
Northland	2500	2.1	84	170	28	R	S
Seafarer	2550	2.3	87	192	35	R	S
Midland	2650	2.6	94	173	44	R	S
Kentwood	2700	2.6	97	234	38	S	S
Wesland	2700	2.7	97	205	37	R	S
Ex Rico 23	2800	2.8	98	206	20	R	S
Fleetwood	2900	2.8	101	195	48	R	S
Steuben Yellow-Eye	2850	2.5	99	486	24	S	S

1 *Three-Year Average (1981-1983) over 18 tests*

2 *See also Disease and Insect Recommendations. R (resistant); S (susceptible)*

Table 47. Phosphate and Potash Requirements for Field Beans and Peas Based on OMAF Soil Tests

Phosphorus Soil Test	Rating	Phosphate (P_2O_5)[1] Required — kg/ha	Potassium Soil Test	Rating	Potash (K_2O)[1] Required — kg/ha
0 - 3		80	0 - 15		120
4 - 5		60	16 - 30		110
6 - 7	LOW	50	31 - 45	LOW	90
8 - 9		40	46 - 60		80
10 - 12		30	61 - 80		60
13 - 15	MEDIUM	20	81 - 100	MEDIUM	40
16 - 25	HIGH	0	101 - 120		30
26 - 60	VERY HIGH	0	121 - 150	HIGH	0
61+	EXCESSIVE[2]	0	151 - 250	VERY HIGH	0
			251+	EXCESSIVE[2]	0

100 kg/ha = 90 lb/ac

1 *Where manure is applied reduce the fertilizer application according to the amount and quality of manure (see Manure in Soils section). Example of fertilizer application: If a field bean crop is not manured and the soil tests are 9 for phosphorus and 85 for potassium, the phosphorus requirement is 40 kg/ha and the potash requirement 40 kg/ha (see above table). Ten kilograms of nitrogen are also recommended. These nutrients can be supplied by broadcasting or banding 170 kg/ha of 6-24-24 fertilizer.*

2 *For a nutrient which has an excessive rating by soil analysis, the application of this nutrient in fertilizer or manure may cause problems due to reduced crop yield or quality. Phosphorus additions may also increase the risk of water pollution. Potash additions may induce magnesium deficiency on soils low in magnesium.*

Nitrogen

Nitrogen fertilizers are not usually required for field beans and peas but where phosphate fertilizers are banded a small amount of nitrogen (10 kg N/ha) may improve the availability of the phosphate. Where field bean yields have been low due to bronzing or root rots, apply an additional 100 kg nitrogen per hectare before planting. Under these conditions nitrogen will increase yield but will not cure the bronzing or the root rot.

Phosphate and Potash

Phosphate and potash requirements for field beans and peas are presented in Table 47. These recommendations are based on soil tests conducted in the Ontario Ministry of Agriculture and Food soil testing laboratory at the Department of Land Resource Science, University of Guelph. These tables should not be used with soil test readings from other soil testing laboratories unless the methods used are identical to those used in the OMAF laboratory.

Methods of Application

Fertilizer should not be placed in contact with bean or pea seeds. The fertilizer may be broadcast and plowed down or worked in before planting, or a planter with a separate attachment for fertilizer placement may be used to place the fertilizer 5 cm to the side and 5 cm below the seed.

Micronutrients

Zinc deficiency has been reported on field beans in Michigan but appears to be very rare in Ontario. Other micronutrient deficiencies have not been diagnosed in peas and beans. Beans are very sensitive to boron and should not be grown the year after rutabagas receiving boron.

DISEASE AND INSECT CONTROL IN FIELD BEANS

Seed Treatment

Follow the precautions under Seed Treatments in the General Information on Pesticide Usage section when applying any chemical seed treatment.

Seed treatments containing diazinon, lindane and a fungicide are required to protect large-seeded crops from seed maggots, wireworms and seed decay organisms. (See Precautions with Pesticides section).

Application of the insecticides alone may result in reduced germination. Diazinon is used to control seed maggots; lindane to control wireworms and the fungicide to control disease organisms. The combination seed treatment should be applied every year because maggots are usually an annual pest and the kill of the wireworm seldom is high.

Combinations of diazinon, lindane and captan are available from seed suppliers in individual containers. Directions stated on the container should be followed with care; the mixing in the planter box must be thorough or germination will be reduced and insect control will be poor. For your protection while mixing the chemicals with the seed, use a wooden paddle and wear rubber gloves and a respirator. Do not breathe the dust stirred up during mixing.

DISEASES

Bacterial Blight All bean varieties are susceptible to common bacterial blight but the four commercial white bean varieties are resistant to Halo Blight. The bacteria usually do not overwinter in the field but, to be safe, allow one year between crops. Do not apply manure containing bean refuse to land intended for beans. Almost all infections begin from infected seed. **Do not plant seed which has been harvested from diseased plants.** To avoid spreading this disease, stay out of the fields when foliage is wet.

Anthracnose The currently recommended varieties of white bean are resistant to alpha, beta and gamma races of anthracnose. However, they are not resistant to the delta race which first appeared in 1976.

The fungus survives from year to year on seed and on infected plant straw, in the soil and on farm machinery. Rainy weather favors this disease as spores are splashed from diseased areas and carried in wind-borne water droplets throughout the field.

Until plant breeding programs provide a measure of control through resistance, the following practices should be followed:

1. Plant anthracnose-free seed.
2. If disease condition of seed is not known, treat with DCT at the recommended rates. These products will not control anthracnose if seed is severely infested.
3. A two- to three-year rotation is essential.
4. Do not cultivate when plants are wet.
5. Clean planting and harvesting equipment thoroughly when moving from one bean field to another.

Root Rot and Bronzing (ozone damage) occur in almost every field every year. The amount of damage is related to the general health of the crop as well as to the amount of root-rotting organisms in the soil or ozone in the air. Beans which are not growing well have more injury from root rot and bronzing than vigorous beans.

Eliminating these diseases is impossible. Yield losses caused by them can be reduced by following good soil management practices.

1. Increase nitrogen levels; see Fertilizers for Field Beans and Peas.
2. Keep organic matter as high as possible.
3. Maintain or build up good soil tilth by not overworking the soil or working it when it is too wet.

White Mold (Sclerotinia) usually begins to appear by mid August. The fungus disease develops from windblown spores produced from small black bodies (sclerotia) that survive in the soil over winter. The sclerotia are found on and in stems and pods of infected plants and at harvest are scattered over the soil. These sclerotia are not toxic to livestock. Initial infection occurs on plant tissues such as older flowers or possibly lower leaves that have died from other causes. Infection of healthy pods, stems and leaves results from infected plant parts coming in contact with healthy plant tissues. Weather conditions, especially rainfall, play a critical role in disease development. In areas where disease is widespread, crop rotation has not given control. Spraying with fungicides is considered essential in fields with the following conditions.

- a past history of white mold;
- above average foliage growth;
- exposure to continuous wetness and air temperatures between 15 and 20°C (day and night temperatures) for more than 48 hours (fewer hours if temperatures are higher).

For most effective control, foliar sprays must be applied at first bloom prior to appearance of disease. Sprays applied after disease first appears do not control white mold effectively.

Table 48. White Mold Control

Fungicide	Formulation[1]	Product per ha
Benlate	50 W	1.75-2.25 kg
Rovral	50 W	1.0 kg
Easout	70 W	1.75-2.25 kg
Botran	75 W	3.25 kg
Bravo[2]	500 F	4.8 L

Do not feed bean refuse to livestock.

1 *F (flowable); W (wettable).*

2 *Do not apply after full bloom.*

INSECTS

Green Cloverworm is a greenish caterpillar that feeds on bean foliage, causing holes in leaves and reducing yield. Shake worms from plants onto paper to count them. **If more than five caterpillars are found per 30 cm of row, apply an insecticide as listed below:**

Table 49. Cloverworm Control

Insecticide	Formulation[1]	Product per ha	Days to Harvest
Endosulfan or Thiodan	400 EC 4 EC	1.4 L	2
+Guthion	50 WP 240 SC	1.1 kg 1.75-2.25 L	3
Sevin	80S, or 85 WP	4.5 kg	3

+ *Minimum period before reentry into treated areas is 48 hours. See Reentry into Treated Areas.*

1 *EC (Emulsifiable Concentrate); S (Sprayable); SC (Sprayable Concentrate); WP (Wettable Powder).*

Mexican Bean Beetles and Potato Leafhoppers cause damage some years. Growers should check the descriptions below and treat their plants when insects are causing damage.

Mexican bean beetles are oval in shape with 16 small black spots on their otherwise yellowish back. The larvae are easily identified by their yellow color and the presence of six rows of long branching, black-tipped spines.

Potato leafhoppers are pale green, wedged-shaped insects about 0.3 cm long. They are best identified by observing how they walk. They can walk equally well forwards, backwards and sideways when disturbed.

Leafhoppers are more likely to cause reductions in yield when they are numerous early in the season and the crop is under stress from drought. When control is necessary, apply

one of the insecticides in the table. A second application may be necessary; recheck the fields.

Table 50. Mexican Bean Beetle and Leafhopper Controls

Insecticide	Formulation[1]	Product per ha	Days to Harvest	Comments
Cygon	480 E	0.7-1.0 L	7	Do not use straw for feed or bedding.
Endosulfan or Thiodan	400 EC 4 EC	1.4 L	2	
+Guthion	240 SC	2.25 L	3	
Malathion	500 EC	1.3-2.5 L	1	
Sevin	50 WP 80 S or 85 WP	1.1-2.25 kg 0.7-1.25 kg	3	Use lower rate for bean beetles.
Sevin XLR	480 Su	1.5-2.5 L		

\+ *Minimum period before reentry into treated areas is 48 hours. See Reentry into Treated Areas section.*

1 *E or EC (Emulsifiable Concentrate); S (Sprayable); SC (Sprayable Concentrate); WP (Wettable Powder); Su (Suspension).*

Grasshoppers Maintain weed-free headlands and fence-rows. If grasshoppers become a problem, spray outer rows of the field.

Table 51. Grasshopper Control

Insecticide	Formulation[1]	Product per ha	Days to Harvest
Diazinon	50 WP	1.1 kg	7
Malathion	25 WP	3.4 kg	7
	500 EC	1.7 L	
Sevin	50 WP	3.4 kg	3
	80 S or 85 WP	2.0 kg	

1 *E or EC (Emulsifiable Concentrate); S (Sprayable); WP (Wettable Powder).*

WEED CONTROL IN FIELD BEANS AND PEAS

For weed control recommendations see OMAF Publication 75, *1984 Guide to Chemical Weed Control.*

CROP MANAGEMENT

Soybeans should be planted from May 15 to May 30. Later planting will cause marked yield decreases. Choose a variety that will mature every year in your locality. See Heat Units Available for Corn Production, Figure 1.

When you intend to sow fall wheat following a soybean crop, consider a soybean variety earlier than a full-season variety for your area.

When seeding, make allowance for variety seed-size differences. A seeding rate of 67 kg/ha (1 bu/ac) is adequate for all varieties in 36 to 71 cm rows. Eighteen centimetre rows are recommended under short growing season conditions. Adjust seeding rate upward for lower germination or for soils which crust badly. Uniform depth of seeding 3 to 5 cm is important.

Table 52. Planting Recommendations

Row width centimetres	kg/ha	Seed drop per metre of row	
		5500 seeds/kg	6600 seeds/kg
71	67	27	33
53	67	21	26
36	67	14	16
18	90	10	10

Inoculation

When soybeans are grown on land for the first time, inoculation with soybean rhizobia is essential for high yields. Under these conditions, soil-applied granular inoculants produce more consistent nodulation and higher yields than seed-applied powders. Therefore, granular inoculant is recommended on new soybean land, at rates from 5 kg/ha in wide rows up to 10 kg/ha in rows 18 cm apart.

Granular inoculant is applied through granular insecticide applicators on a corn planter, with delivery tubes brought forward to place the inoculant in the seed furrow. In a grain drill, the grass seed box can be used for granular inoculant with tubing added to drop the inoculant with the seed. With newer drills, the granular inoculant may be applied through the fertilizer hopper.

After nodulated soybeans have been grown on a field, the use of granular inoculant is not recommended because it usually does not cause yield increases. If soybeans have only been grown for one or two years, or if they have not been grown for several years, soybean seed should be inoculated with powdered peat inoculant to ensure nodulation. In fields which have grown soybeans many times, inoculation is not necessary.

Table 53. Soybean Variety Recommendations and Description

Variety	Heat Units Required	Hilum Color	Seeds per kilogram	Phytophthora Root Rot Reaction % Plant Loss[1]	Distributor[2]
Maple Presto	2200	light-brown	6390	12	SeCan
Maple Amber[3]	2450	brown	5850	17	public variety
McCall	2550	yellow	6310	35	public variety
Maple Arrow	2550	brown	5770	24	public variety
Bicentennial	2600	brown	4570	9	SeCan
Evans	2700	yellow	6090	29	public variety
Ace[3]	2800	yellow	4030	25	W.G. Thompson & Sons Ltd.
0877	2800	light-gray	5670	29	Pioneer Hi-Bred Ltd.
Crusader	2900	yeliow	5780	28	W.G. Thompson & Sons Ltd.
Hodgson	2900	buff	5950	13	public variety
AP10	2900	yellow	5780	31	King Grain Ltd.
Prestige	2900	brown	6040	45	King Grain Ltd.
A1564	2900	yellow	5920	11	Maple Leaf Mills
S1346	2950	yellow	5530	10	Northrup King Seeds Ltd.
B152	2950	yellow	5850	5	Northrup King Seeds Ltd.
A1937	2950	buff	6230	11	Maple Leaf Mills
Hawk	3000	black	5710	7	W.G. Thompson & Sons Ltd.
1677	3000	yellow	6990	25	Pioneer Hi-Bred Ltd.
1981	3000	black-brown	5010	19	Pioneer Hi-Bred Ltd.
Eagle	3000	buff	6170	11	W.G. Thompson & Sons Ltd.
Coles	3050	yellow	5320	15	public variety
DSR171	3050	black	6230	22	U.C.O.
B203	3050	yellow	6670	8	Northrup King Seeds Ltd.
A2481	3100	buff	6100	26	Maple Leaf Mills
A2575	3100	buff	6060	16	Maple Leaf Mills
Falcon	3100	yellow	6410	32	W.G. Thompson & Sons Ltd.
B220	3100	yellow	6330	30	King Grain Ltd.
Dawn	3100	yellow	6540	25	U.C.O.
Kentland	3100	buff	6520	6	Northrup King Seeds Ltd.
Premier	3100	yellow	6240	9	King Grain Ltd.
Starlite	3100	yellow	6270	20	Maple Leaf Mills
S2596	3100	brown	5470	18	Northrup King Seeds Ltd.
Amsoy 71	3150	yellow	5780	37	public variety
Corsoy 79	3150	yellow	6580	3	public variety
Harcor	3150	yellow	6490	25	public variety

1 *Three-year average (1981-83) in a field heavily infested with phytophthora (See Disease and Insect Control in Soybeans).*

2 *See Distributor Addresses in General Section.*

3 *Metribuzin should not be used on Maple Amber or Ace.*

Table 54. Agronomic Data

Testing Areas	Variety	Heat Unit Rating	Yield[1] (t/ha)	Yield[2] Index %	Days from Planting to Maturity	Plant Height (cm)	Lodging 1=standing 5=flat
3-year average of 9 trials at Ottawa, Elora Brussels and Kemptville	Maple Presto+	2250	2.1	76	100	67	1.2
	Maple Amber	2450	2.6	95	108	71	1.4
	McCall	2550	2.8	103	112	72	1.5
	Maple Arrow	2550	2.9	106	114	77	1.6
	Bicentennial	2600	3.0	110	116	79	2.2
	Evans	2700	3.0	110	125	88	2.4
	Average Yield	2.7					
3-year average of 9 trials at Woodstock, Denfield, and Centralia	Maple Arrow	2550	2.8	98	108	67	1.4
	Bicentennial	2600	2.9	100	109	69	1.7
	Evans	2700	2.7	93	114	76	1.5
	0877	2800	2.9	100	116	79	1.7
	Ace	2800	3.2	111	117	69	1.5
	Hodgson	2900	2.8	98	120	81	1.6
	Average Yield	2.9					
3-year average of 8 trials at Fingal (clay), Inwood (clay) and Ridgetown (loam)	Evans	2700	3.0	87	116	84	1.9
	Crusader	2850	3.4	99	119	87	2.2
	Prestige	2900	3.2	93	120	92	2.5
	Hodgson	2900	3.4	99	121	88	1.7
	AP10	2900	3.4	99	121	87	2.4
	A1564	2900	3.3	96	122	84	2.2
	S1346	2950	3.4	99	123	77	1.3
	B152	2950	3.6	105	123	78	1.5
	A1937	2950	3.5	102	124	89	2.0
	Hawk	3000	3.4	99	126	80	2.7
	1677	3000	3.5	102	127	88	2.2
	1981	3000	3.5	102	127	93	2.1
	Coles	3050	3.4	99	128	104	2.9
	DSR171	3050	3.5	102	128	96	2.4
	B203	3050	3.5	102	128	89	2.3
	Premier	3100	3.4	99	130	90	2.2
	A2575	3100	3.6	105	131	99	1.8
	Kentland	3100	3.6	105	131	91	2.3
	S2596	3100	3.6	105	132	87	1.8
	Starlite	3100	3.6	105	133	99	2.7
	Average Yield	3.4					

Continued on Page 66

Table 54. Agronomic Data (Cont'd.)

Testing Areas	Cultivar	Heat Unit Rating	Yield[1] (t/ha)	Yield[2] Index %	Days from Planting to Maturity	Plant Height (cm)	Lodging 1=standing 5=flat
3-year average of 9 trials at Chatham (loam), Woodslee (clay), and Malden (loam)	Hodgson	2900	3.4	102	111	84	1.6
	Prestige	2900	3.2	97	111	90	2.2
	A1564	2900	3.3	100	112	91	2.1
	S1346	2950	3.4	102	112	76	1.1
	A1937	2950	3.4	102	113	85	1.7
	1981	3000	3.3	100	114	86	2.2
	1677	3000	3.3	100	115	83	1.6
	Eagle	3000	3.2	97	117	81	1.7
	Coles	3050	3.3	100	117	96	2.6
	DSR171	3050	3.3	100	117	93	2.2
	A2481	3100	3.4	102	118	84	1.6
	A2575	3100	3.3	100	119	93	1.4
	Falcon	3100	3.2	97	118	89	1.3
	B220	3100	3.3	100	119	90	1.5
	Dawn	3100	3.3	100	119	96	2.6
	Kentland	3100	3.4	102	120	89	2.0
	Premier	3100	3.3	100	119	86	1.9
	Starlite	3100	3.3	100	120	94	2.5
	S2596	3100	3.4	102	120	83	1.4
	Amsoy 71	3150	3.3	100	121	101	2.4
	Corsoy 79	3150	3.3	100	121	97	2.5
	Harcor	3150	3.3	100	121	100	2.8
	Average Yield	3.31					

1 *t/ha = 1 tonne per hectare = 15 bu/ac*

2 *For each test area Yield Index is expressed as a percentage of the average yield of all recommended varieties grown in that test area.*

\+ *Maple Presto is a very early variety considered to be too early and too low yielding for general use in Ontario. However, this variety may be considered for late planting situations in short season areas.*

FERTILIZERS FOR SOYBEANS

Fertilizer requirements for soybeans in Ontario can best be estimated by using a soil test along with information on past management such as manure. Fertilizer recommendations are based on the results of trials run on research stations and farm fields in Ontario. The recommendations in this publication can be expected to produce the highest economic returns from the crop when good or above average management is used.

To provide dependable fertilizer recommendations, each field should be tested at least once every third year. When large amounts of nutrients are removed from sandy soils (e.g. with crops such as hay, corn silage, potatoes, tomatoes) annual testing is advisable as potash soil tests can change rapidly under those conditions.

Where a soil test is not available a rough estimate of fertilizer requirements can be obtained from the accompanying table using the following guidelines:

a. Where the field has been fertilized regularly for a number of years or heavily in recent years, use one of the rates of phosphate and potash recommended for the MEDIUM soil test rating. (See Table 55.)

b. If the field has received little fertilizer in the past, use one of the rates recommended for a LOW soil test rating. (See Table 55.) One exception is clay and clay loam soils. Some clay and clay loam soils are naturally high in potassium and do not require any potassium fertilizer. Only a soil test can adequately determine potash requirements.

Nitrogen

Where soybeans have not been grown recently, the seed should be inoculated with nitrogen fixing bacteria before seeding.

Nitrogen fertilizers are not usually required for soybeans but where phosphate fertilizers are banded a small amount of nitrogen (10 kg N/ha) may improve the availability of the phosphate.

Phosphate and Potash

Phosphate and potash requirements for soybeans are presented in Table 55. These recommendations are based on soil tests conducted in the Ontario Ministry of Agriculture and Food soil testing laboratory at the Department of Land Resource Science, University of Guelph. These tables should not be used with soil test readings from other soil laboratories unless the methods used are identical to those used in the OMAF laboratory.

Table 55. Phosphate and Potash Requirements for Soybeans Based on OMAF Soil Tests

Phosphorus Soil Test	Rating	Phosphate (P_2O_5)[1] Required - kg/ha	Potassium Soil Test	RATING	Potash(K_2O)[1] Required -kg/ha
0 - 3	LOW	80	0 - 15	LOW	120
4 - 5	LOW	60	16 - 30	LOW	110
6 - 7	LOW	50	31 - 45	LOW	90
8 - 9	LOW	40	46 - 60	LOW	80
10 - 12	MEDIUM	30	61 - 80	MEDIUM	60
13 - 15	MEDIUM	20	81 - 100	MEDIUM	40
			101 - 120	MEDIUM	30
16 - 25	HIGH	0	121 - 150	HIGH	0
26 - 60	VERY HIGH	0	151 - 250	VERY HIGH	0
61+	EXCESSIVE[2]	0	251+	EXCESSIVE[2]	0

100 kg/ha = 90 lb/ac

1 *Where manure is applied reduce the fertilizer application according to the amount and quality of manure (see Manure in soils section). Example of fertilizer application: If a soybean crop is not manured and the soil tests are 9 for phosphorus and 85 for potassium, the phosphate requirement is 40 kg/ha and the potash requirement 40 kg/ha (see above table). Ten kilograms of nitrogen are also recommended. These nutrients can be supplied by broadcasting or banding 170 kg/ha 6-24-24 fertilizer.*

2 *For a nutrient which has an excessive rating by soil analysis, the application of this nutrient in fertilizer or manure may cause problems due to reduced crop yield or quality. Phosphorus additions may also increase the risk of water pollution. Potash additions may induce magnesium deficiency on soils low in magnesium.*

Micronutrients

Manganese is the only micronutrient deficiency diagnosed in soybeans in Ontario although zinc deficiency may be expected to show up in the future where the surface soil has been lost by erosion.

With Manganese deficiency, the upper leaves range from pale green (slight deficiency) to almost white (severe deficiency) while the veins remain green. In addition to deficiency symptoms both soil tests and plant analyses are useful in predicting where manganese deficiencies are likely to occur. Both are available at the OMAF soil testing and plant analysis laboratory.

Correct the deficiency as soon as detected by spraying the foliage with 2 kg of manganese/ha from manganese sulfate (8 kg of manganese sulfate/ha) or 0.4 kg of manganese/ha in chelated form in 200 L of water.

Use a "spreader sticker" in the spray. If the deficiency is severe, a second spray may be beneficial.

Never use spray equipment which has been used for spraying hormone-type herbicides such as 2,4-D. Beans are very sensitive to this type of herbicide.

Soil application is not a good way to apply manganese regardless of the source because of the large amounts required.

For further details on manganese deficiency and on methods of application refer to OMAF Factsheet, *Manganese in Soybeans and Small Grain Production*, Agdex 100/531.

Methods of Application

Fertilizer should not be placed in contact with soybean seeds. The fertilizer may be broadcast and plowed down or worked into the soil either in the fall or spring; or a planter with a separate attachment for fertilizer placement may be used to place the fertilizer 5 cm to the side and 5 cm below the seed.

DISEASE AND INSECT CONTROL IN SOYBEANS

Seed Treatments

Follow the precautions under Seed Treatments in General Information in Pesticide Usage section, when applying any chemical seed treatment.

Seed treatments are recommended for control of seed maggots, wireworms and seed decay organisms. Lindane and diazinon are the two most commonly used insecticides found in combination seed treatments. When used alone they can cause plant injury by reducing plant stand, growth and yield. The addition of a fungicide not only makes the effect of these products safer, but will provide control of seed and seedling rots.

When desiring full insect and disease protection use products containing diazinon, lindane and captan such as B-3, DLC, DL-Plus or Drillbox DL plus Captan. Only B-3 contains sufficient captan fungicide to be used on untreated soybean seed. DLC, DL-Plus and

Drillbox DL plus Captan contain one half as much captan and therefore should only be used on seed previously treated with a fungicide.

In areas where insect problems are minimal, use seed treatments containing fungicide only, such as captan, carbathiin or thiram.

DISEASES

Downy Mildew appears as yellow, and later, brown spots on the leaves during August and September. In moist weather a pale blue to gray, downy growth of the mildew fungus appears on spots on the lower leaf surface. Severely affected leaves may drop prematurely. Whitish growth of the fungus may encrust the seeds, even within pods that appear healthy. Varieties differ in susceptibility; the variety **Evans** is highly susceptible, but **Maple Arrow** has considerable resistance. Rotate soybeans with other crops and plow under crop refuse.

Powdery Mildew infects soybean leaves under cool, cloudy conditions in late August and early September. The fungus produces a white powdery growth on the upper surface of infected leaves. At present, no control measures are available. The spread of this disease is restricted by dry sunny weather.

White Mold may cause damage to soybeans under cool, wet conditions. Stems, pods and leaves infected with white mold are pale brown and water-soaked in appearance. Frequently a white cotton-like growth and small dark bodies (sclerotia) can be seen on or within stems of diseased plants. The sclerotia survive many years in soil. In summer, disease arises from airborne spores produced on the sclerotia. Crop rotation may be useful for disease control in areas where white mold is uncommon. White mold is more likely to occur in soybeans following any bean crop in which white mold was present in previous years. Avoid this crop sequence if possible. In areas where white mold is common, however, the disease may appear in spite of crop rotation because of windblown spores from other fields. Some differences in disease severity in varieties have been noted. No resistant varieties have been identified but field observations indicate that early varieties in a geographic area are less prone to an epidemic than later varieties. Similarly, varieties with greater lodging resistance tend to be more resistant to white mold. For soybean fields with a history of severe white mold infection, producers should consider planting varieties which require 200-300 fewer heat units than normally available and which possess superior resistance to lodging.

Phytophthora Root Rot is a potential problem where soybeans are grown on clay soils in parts of southwestern Ontario. Diseased plants, 15 to 60 cm tall, wilt and die in June and July. A reddish-brown discoloration extending from the roots to the lower nodes is evident on the stems of wilted plants. Dead plants may occur as either a few in a row or as patches in low areas of fields. A few plants die in late August or September. Control of Phytophthora root rot requires a combination of soybean variety selection and good soil management. Some varieties have a little resistance (see Table 53), however, none of the varieties now grown are completely resistant. Any soil management practice which reduces the chance of soil compaction or waterlogging will decrease the incidence of the disease. On clay soils where Phytophthora root rot may be a problem, the following procedures are recommended.

a. Choose a variety with a low percentage of infected plants (see Table 53).

b. Prepare seedbeds by plowing rather than disking.

c. Do not plow or disk when the soil is wet.

d. Plow in crop residues or manure to improve soil structure.

e. Include crops in a rotation that improves soil tilth.

f. Inspect soybean fields for dead plants in late July or early August.

Rhizoctonia Root Rot has been found in most of the soybean growing areas of southwestern Ontario. Symptoms of the disease are very similar to plants infected with Phytophthora, except reddish lesions produced on roots and lower stems seldom extend above the soil line. There are no commercial varieties that are tolerant to Rhizoctonia.

INSECTS

Insect damage is seldom enough to cause soybean yield losses in Ontario. Green cloverworms may be prevalent in some years. Control measures for green cloverworms and grasshoppers are listed in Tables 51 and 53 in the Field Bean section. Follow precautions for handling chemicals. See Pesticides Section.

WEED CONTROL IN SOYBEANS

For weed control recommendations see OMAF Publication 75, *1984 Guide to Chemical Weed Control.*

CANOLA

CROP MANAGEMENT

Spring canola is a cool-season crop suited to areas with less than 2700 heat units.

Seeding should be done as early as soil conditions permit. Planting time should be late April to early May. Yield reductions will occur if seeding is delayed. Plant 4 to 5 kg/ha of seed in 18 cm rows (15 to 20 seeds per metre) with a grain drill or Brillion-type seeder into a fine, firm seedbed. Planting depth should be 2 to 3 cm if there is adequate moisture, and deeper if necessary to plant in moisture, but not deeper than 4 cm. Seed should be mixed with an insecticide for flea bettle control before calibrating the drill.

Canola is highly susceptible to phenoxy herbicides such as 2,4-D and MCPA. Be sure spraying equipment is cleaned out thoroughly before using on canola.

Spring canola should be swathed when 25% of the seeds in pods from the middle portion of the plants have changed color from green to red or brown. Leave as long a stubble as possible. Swathing when the crop is moist aids flow through the swather. Canola in the swath matures in 5 to 10 days under ideal weather. Seed will not store at more than 10% moisture. However, under good drying conditions, moisture content drops rapidly and combining can begin at about 13% moisture.

For additional information see OMAF Factsheet, *Spring Canola in Ontario*, Agdex 149/10.

VARIETIES

Argentine-type varieties are recommended for most areas with less than 2700 heat units. Polish-type varieties such as **Candle** and **Tobin** normally yield less than Argentine-type varieties and are only recommended for northern Ontario areas where Argentine-type varieties do not mature regularly.

Table 56. Recommended Canola Varieties[1]

Variety	Days from Planting to Maturity	Yield[2] (t/ha)	Lodging 1 = standing 5 = flat
Altex	95	1.5	2.1
Regent	95	1.6	1.6
Tower	96	1.5	1.8

1 *Values shown are averages of 13 trials over 3 years.*
2 *1 t/ha = 893 lb/ac*

FERTILIZERS FOR CANOLA

Fertilizer requirements for canola in Ontario can best be estimated using a soil test along with information on past management such as manure. Fertilizer recommendations are based on the results of trials run on research stations and farm fields in Ontario. The recommendations in this publication can be expected to produce the highest economic returns from the crop when good or above average management is used.

To provide dependable fertilizer recommendations, each field should be tested at least once every third year. When large amounts of nutrients are removed from sandy soils (with crops such as hay, corn silage, potatoes or tomatoes) and manure is not applied, annual testing is advisable as potash soil tests can change rapidly under these conditions.

Where a soil test is not available a rough estimate of fertilizer requirements can be obtained from the accompanying table using the following guidelines.

a. Where the field has been fertilized regularly for a number of years or heavily in recent years, use one of the rates of phosphate and potash recommended for the MEDIUM soil test rating (See Table 57)

b. If the field has received little fertilizer in the past, use one of the rates recommended for a LOW soil test rating. (See Table 57). One exception is clay and clay loam soils. Some clay and clay loam soils are naturally high in potassium and do not require any potassium fertilizer. Only a soil test can adequately determine potash requirements.

NITROGEN

Spring application of 100 kg/ha is recommended unless a legume sod has been plowed down or manure has been applied.

PHOSPHATE AND POTASH

Phosphate and potash requirements for canola are presented in Table 57. These recommendations are based on soil tests conducted in the Ontario Ministry of Agriculture and Food Soil Testing Laboratory at the department of Land Resource Science, University of Guelph. These tables should not be used with soil test readings from other soil test laboratories unless the methods used are identical to those used in the OMAF laboratory.

Table 57. Phosphate and Potash Requirements for Canola Based on OMAF Soil Tests

Phosphorous Soil Test	Rating	Phosphate (P_2O_5)[1] Required - kg/ha	Potassium Soil Test	Rating	Potash (K_2O)[1] Required - kg/ha
0-3	Low	110	0-15	Low	70
4-5		100	16-30		50
6-7		90	31-45		40
8-9		70	46-60		30
10-12	Medium	50	61-80	Medium	20
13-15		20	81-100		20
16-20		20	101-120	High	0
21-25	High	0	121-150		0
26-30		0	151-180	Very high	0
31-40		0	181-210		0
41-50	Very high	0	211-250		0
51-60		0	251+	Excessive[2]	0
61+	Excessive[2]	0			

100 kg/ha = 90 lb/ac.

1 *Where manure is applied reduce the fertilizer application according to the amount and quality of the manure (see Manure in Soils section).*

2 *Excessive ratings may cause reduced yield or quality of the crop.*

Seed Treatment

Canola seed needs to be treated with a combination of fungicide and insecticide. Seed is often imported and may contain the fungus causing black leg. Also, seed decay and damping-off fungi are controlled by fungicides. Insecticides are to control flea beetle during early stages of emergence. Seed may have been commercially treated. Untreated seed should be treated by the grower. Use the following at rates recommended on the label.

Table 58. Canola Seed Treatments

Seed Treatment	Formulation[1]	Fungicide	Insecticide
Vitavax RS	F	3.3% carbathiin 6.6% thiram	50% lindane
	P	3.3% carbathiin 6.7% thiram	50% lindane
Gammasan	P	6% benomyl 10% captan	50% lindane

[1] *F (Flowable); P (Powder)*

DISEASES

White mold (Sclerotinia) Infected plants ripen prematurely, have bleached stem lesions and hard, black, fungal bodies inside infected stems. Avoid rotations including white beans, soybeans, and sunflowers. Use clean seed and rotations of at least four years including unaffected crops such as corn, wheat, barley or oats in the rotation.

INSECTS

Flea Beetles

Two species of flea beetle attack canola. The *striped flea beetle* is about 1.5 mm long and has two cream-colored stripes along its back. The *crucifer flea beetle* is entirely bluish-black and about the same size. Flea beetles jump when disturbed, thus their common name. The adults eat holes through the leaves. Larvae feed on the roots of canola and other cruciferous plants but are not considered damaging.

Both kinds of flea beetle overwinter as adults and can attack canola in the spring after germination. Damage is most severe during the initial three weeks following germination, when young seedlings are killed or seriously damaged. Feeding on the foliage continues during the season but more mature plants are less severely affected. Severe infestations in western Canada have caused 50% reductions in yield. The full extent of damage in Ontario is still unknown.

Control measures are directed against the beetles during the early stages of seedling growth. Insecticides can either be incorporated on the seed as a coating, or can be applied in granular form from the seed box during seeding. Refer to the preceeding section for information for control using seed treatments. Seed treatments provide only a short period of protection (3-7 days) after germination and a supplemental spray may be required. Check seedling fields regularly especially along weedy fencerows. Damage may be more severe in such areas because of the proximity to overwintering sites of the beetles.

Table 59. Flea Beetle Control

	Formulation[1]	Product per ha	Days to Harvest
Seed-furrow application:			
Counter	5G	5.5-11 kg	Planting time only
Furadan	CR-10G	2.8 kg	
Post-emergent spray:			
+ Furadan	480 F	150-275 ml	60
+ Guthion	50 WP 240 SC	150-275 ml 275-550 ml	30 30

1 *G (Granular); F (Flowable); WP (Wettable Powder); SC (Sprayable Concentrate).*

\+ *Minimum period before reentry into treated area in 48 hours. See Reentry into Treated Areas.*

Diamondback Moth The adult is a small light brown moth about 1 cm long. It is best identified by the white diamond-shaped markings along the back when the wings are at rest. Apparently this pest does not over-winter in Ontario. The severity of attack is dependant on the number of moths carried into Ontario each spring on weather systems.

Damage is caused by the larvae which are light green with brown heads and are about 1 cm long when mature. There are three or four generations in Ontario. They feed on the foliage and when numerous they will feed on the pods. This damage results in premature senescence and shattering of pods at harvest.

Table 60. Diamondback Moth Control

Product	Formulation[1]	Product per ha	Days to Harvest
Dylox[2]	80% S P 420 L	1.5 kg 2.75 L	21 21
+ Guthion	50 WP 240 SC	275-550 g .55-1.25 L	30 30

1 *SP (Soluble Powder); L (Liquid); WP (Wettable Powder); SC (Sprayable Concentrate).*

2 *Use Dylox if Canola is in bloom because it is less hazardous to bees.*

\+ *Minimum period before reentry into treated area is 48 hours. See Reentry into Treated Areas.*

WEED CONTROL IN CANOLA

For weed control recommendations, see OMAF Publication 75: *1984 Guide to Chemical Weed Control.*

SOIL MANAGEMENT AND FERTILIZER USE

Ontario currently uses about 1,000,000 tonnes of fertilizers annually. High yields can be produced efficiently only when fertilizer use is related to the fertility level of the soil and to other additions of nutrients in manure, crop residues, etc. At one extreme, on very low fertility soils, it is occasionally profitable to add as much or more nitrogen, phosphorus, or potassium in the fertilizer as a crop removes. At the other extreme, on high fertility soils or following heavy application of manures, fertilizer may not be profitable and occasionally may reduce yields.

SOIL TESTING

Why Soil Test?

Soil testing is currently by far the most accurate tool available to Ontario farmers to determine the amounts of phosphorus, potassium and magnesium fertilizers and lime which should be applied to field crops.

Alternatives to the Soil Test

1. Plant analysis is the main tool used for tree fruits and can serve as additional information supporting the soil test for field and vegetable crops.

2. Nutrient deficiency symptoms on crop leaves are helpful in some cases but have serious drawbacks in others, particularly with potassium and phosphorus.

3. It is occasionally suggested that a farmer apply the amounts of nutrients removed by the crop. This has some application for nitrogen as we do, with some crops, apply close to what the plant removes. It has little relevance for other nutrients in Ontario. Many of our clay and clay loam soils have sufficient potassium to last for many years and application of potassium each year on those soils is a waste of money and ignores one of the few advantages which clay soils have over coarser-textured soils.

The soil testing program is the main guide along with help from plant analysis and nutrient deficiency symptoms to determine your fertilizer requirements for a specific crop on a specific field.

What does the OMAF Soil Testing Program Provide for the Farmer?

Fertilizer recommendations based on soil test results are made by Agricultural Representatives, Fruit and Vegetable Specialists and Soils and Crops Specialists, in county and district offices of the Ministry of Agriculture and Food.

The soil testing program provides recommendations for nitrogen, phosphate, potash and magnesium fertilizer along with recommendations for the amount and type of lime you should apply. These recommendations are expected to produce maximum profits under recommended management methods. Some fertilizer is recommended at soil test levels slightly above those where crop response is profitable. This is done (a) for maintenance (to maintain high soil nutrient levels), and (b) to allow for some error in sampling the field. For high value crops such as tobacco the maximum profit we aim for will require essentially the same amount of fertilizer as maximum crop value (maximum yield with high quality). For low value crops such as oats there may on occasion be a slight yield response to rates of fertilizer above those recommended for maximum profit. However, trials on farm fields with corn have shown no yield response to rates of fertilizer above those recommended by soil test.

Micronutrient Tests

Manganese and zinc tests are provided by the OMAF service. In the case of zinc on corn

the soil test is best used in conjunction with visual deficiency symptoms. With manganese, plant analysis, visual symptoms and the soil test are all useful. The OMAF service does not provide a soil test for boron, copper or iron. Tests for these elements range from rather unreliable in the case of boron, to useless in the case of copper on Ontario soils. Plant analysis and visual symptoms are useful for determining boron and copper needs. Iron deficiency has not been a problem on field crops in Ontario.

Soil Tests from Other Laboratories

Each year a number of farmers ask OMAF staff to interpret soil test results from other laboratories. Provided the other laboratory uses the identical chemical tests used in the OMAF laboratory and expresses their test results in the same units, the OMAF fertilizer requirements for phosphorus and potash can be applied. However, it is rare that this is the case.

Only soil tests using chemical extractants which have been calibrated by a number of field experiments on Ontario soils can be relied on to provide accurate fertilizer recommendations. Be certain that the service you are using measures up to these standards.

A number of laboratories provide tests such as exchange capacity, aluminum and copper not provided through the OMAF services. These are not provided by the OMAF service because they have not been found to contribute to better fertilizer recommendations. Research has shown that on Ontario soils use of exchange capacity to adjust potash recommendations leads to less reliable recommendations than are now provided.

Soil Sampling

Soils may be sampled with a sampling tube or with a shovel. Each field, or uniform section of a field should be sampled separately. At least 20 soil cores 15 cm deep should be taken from any field or area sampled up to 5 ha in size. For fields larger than 5 ha, proportionately more cores should be taken. The more cores taken the more likely the soil sample is to provide a reliable measure of the fertility in the field. The soil can be collected in a clean pail, the lumps should be broken, the soil mixed well and a soil sample box forwarded for testing. The area sampled should be traversed in a zigzag pattern to provide a uniform distribution of sampling sites. Parts of a field that differ in appearance of soil or crop, in previous fertilization, manuring or liming should be sampled separately if they are large enough to fertilize separately. It can be quite informative to sample problem areas separately, occasionally, even if they are too small to fertilize separately. Avoid sampling recent fertilizer bands, dead furrows, areas adjacent to gravel roads or where lime, manure, compost or crop residues have been piled.

When to Sample

Each field should be sampled once every two to three years. Potash levels can change quickly where large amounts of nutrients are removed from sandy soils (for example with crops such as alfalfa hay, corn silage, potatoes or tomatoes) and manure is not returned. Under these conditions samples should be taken each year.

The results of soil tests are forwarded to the county and district offices of the Ontario Ministry of Agriculture and Food within two weeks of receipt of samples in the laboratory. However, to allow time for mailing and analysis, soil samples from fields to be fertilized for spring seeding crops should be taken the previous fall. Because of the rush of harvest and the frequency of poor weather late in the fall, summer may be a more convenient time to sample for some farmers. Soil samples from fields to be fertilized for fall wheat, or from hay and pasture fields to be fertilized in late summer, should be taken in the spring or early summer.

Sample Boxes and Information Sheets

Soil sample boxes and information sheets may be obtained from any district or county office of the Ministry of Agriculture and Food or from the Soil and Plant Analysis Laboratory, Department of Land Resource Science, University of Guelph, Guelph, Ontario N1G 2W1.

Table 61. Analyses Available through the Soil Testing and Plant Analysis Laboratory, Department of Land Resource Science, University of Guelph

	Material	Analyses	Availability	Cost/Sample
1.	Farm soils	Plant available phosphorus, potassium and magnesium + pH (calcium and salt concentration[1] if required)	all times	no charge - cost borne by Ontario Ministry of Agriculture and Food
2.	Home garden and lawn soils	As above	all times	$1.00
3.	Soil	Available manganese and zinc	all times	$3.00
4.	Soil	Organic matter	all times	$5.00
5.	Soil	Texture (% sand, silt and clay)	enquire at lab	quoted on request
6.	Soil	Other analyses may be available for groups of over 20 samples	enquire at lab	quoted on request
7.	Liming materials	Calcium and magnesium content neutralizing value, particle size analysis	all times	$15.00
8.	Dried plant and other organic materials[2]	Nitrogen, phosphorus, potassium, calcium, and magnesium	all times	$14.00
9.	Dried plant and other organic materials[2]	Boron, copper, manganese and zinc	all times	$14.00
10.	Dried plant and other organic materials[2]	9 elements listed in 8 and 9	all times	$18.00
11.	Manure and other moist organic matter	Nitrogen, phosphorus, potassium, calcium, and magnesium and % DM	all times	$17.00
12.	Manure and other moist organic matter	Boron, copper, manganese and zinc	all times	$13.00
13.	Manure and other moist organic matter	9 elements listed in 11 and 12	all times	$16.00
14.	Dried plant, manure, and other organic materials	Sulfur, sodium, iron,	enquire at lab	quoted on request

1 *Electrical conductivity.*

2 *Analysis of feed samples is arranged through the Department of Animal & Poultry Science.*

Management practices which affect a soil test recommendation are: manure application, legume sod plowed down, and the crop to be fertilized. This information is essential for a reliable fertilizer recommendation, and should be recorded on the field information sheet which must accompany the soil sample sent in for analysis.

Changes in Crop or Management

Fertilizer requirements on the OMAF soil test report are for specific crops and management. If the crop management is changed in regard to legumes plowed down or manure applied, the adjustments in fertilizer requirements may be made using the manure and legume sod adjustments in Tables 62, 63 and 64. If the crop is changed from that for which the recommendation was made, a new recommendation can be obtained by looking up the appropriate table under the specific crop section in this publication.

NITROGEN ADJUSTMENT FOR LEGUMES PLOWED DOWN

When sod containing perennial legumes such as alfalfa, trefoil and clover are plowed under, they supply an appreciable amount of nitrogen to the following crop. The accompanying table shows reductions which should be made in nitrogen fertilizer applications to crops following sod containing legumes.

Table 62. Adjustment of Nitrogen Requirement Where Sod Containing Legumes is Plowed Down

Type of Sod	For all Crop Deduc* from N Requirement kg N/ha
Less than 1/3 legume	0
1/3 to 1/2 legume	55
1/2 or more legume	110
Perennial legumes seeded and plowed in the same year.	20[1]

1 *Applies where the legume stand is thick and over 15 cm high.*

MANURE

Manure can supply organic matter and an appreciable part of the nutrients required for production of crops.

Manure Storage

For maximum conservation of plant nutrients manure should be stored in a way that saves the liquid portion and allows as little exposure to the air as practicable.

Where to Use Manure

Manure is used most effectively when applied for crops that require nitrogen and on soils that require phosphorus and potassium. Manure should not be supplied at rates supplying more nitrogen than the crop requires. Corn and grass hay or pastures have higher nitrogen requirements than many other crops and therefore respond more to nitrogen in manure. Legumes such as alfalfa, trefoil and soybeans do not make efficient use of the nitrogen in manure.

Manure on Perennial Legumes

Do not apply manure to perennial legumes such as alfalfa and trefoil when there is snow

cover because ice frequently forms under the manure and can kill the plants. If manure must be applied to perennial legumes it should be applied to the thinnest or oldest stands, preferably after the first cutting.

Applications to Cereals

Manure or nitrogen fertilizers applied to cereals at rates supplying more nitrogen than the crop requires can cause lodging and should be avoided.

Manure on Grass Sod

Manure is an effective source of nutrients for grass sod. However, where manure is to be applied in late spring or summer some nitrogen fertilizer should be applied early in the spring.

Manure on Leaves

Avoid application of liquid manure to crop foliage as it can damage the crop. On perennial forages application to the foliage cannot be avoided but applications early in the spring or immediately after haying are preferred.

Short-Term Value of Manure

The following table shows the reductions in fertilizer application which are recommended for a particular crop where manure is applied in the year that the crop is grown. These values assume, for manure applied in the spring and not immediately covered with soil, that 50% of the nitrogen (75% for poultry manure), 40% of the phosphate and 90% of the potash are as available in the year of application as the nutrients in manufactured fertilizer.

Long-Term Value of Manure

The long-term availability of phosphorus, potassium and magnesium in manure is best measured by soil tests. Some of the nitrogen in cattle and swine manure also continues to become available for plant growth and affects the nitrogen fertilizer requirements in the years after application. Adjustments for residual nitrogen in manure are presented in the accompanying table.

These adjustments apply while manure continues to be used and for the first year after manure application ceases. In addition to adjustments for the residual long-term value, the normal short-term adjustment in nitrogen requirement should also be made for manure applied in the year the crop is grown, as indicated in the accompanying table.

No adjustment should be made for the long-term effects of poultry manure because most of the available nitrogen it contains is released in the year of application.

Table 63 Adjustment of Nitrogen Requirement for Value of Cattle or Swine Manure Applied in Previous Years

Rate of Manure Application		Consecutive Years of Manure Application	Reduction in Crop Nitrogen Requirement kg N/ha
Solid t/ha[1]	Liquid m^3/ha[1]		
20	50	5	20
20	50	10	30
40	100	3	20
40	100	5	30
40	100	10	30

1 *66 bu. manure = 1 metric tonne approximately. 10 tonne/ha = 4.5 ton/ac. One metre^3 = 220 imperial gallons. One metre^3/ha = 90 gal/ac.*

Table 64. Reductions in Fertilizer Application where Manure is Applied in the Same Crop Year[1]

Class of Livestock	Nitrogen (kg/ha)			Phosphate	Potash
	F.&.W.[2]	Spr.[2]	Spr.C[2]	P_2O_5 (kg/ha)	K_2O (kg/ha)
Liquid Manure at 10 cubic metres/hectare (One cubic metre = 220 imp. gal; one cubic metre/ha = 90 gal/ac.)					
Cattle, Mixed Livestock	5	10	12	4	16
Swine	8	15	19	7	14
Poultry	23	46	58	22	26
Solid Manure at 10 tonnes/hectare (66 bu. or 2.40 cubic metres of solid manure = 1 metric tonne approximately. Ten t/ha = 4.5 ton/ac.)					
Cattle, Mixed Livestock	12	24	30	10	44
Swine	15	30	38	20	26
Poultry	70	140	175	75	96

1 *These adjustments are based on slightly below average quality manure.*

2 *F. & W. denotes fall and winter applied manure; Spr. denotes spring applied and not covered immediately, including surface application after seeding; Spr. C. denotes spring applied manure injected or otherwise covered within one day of application.*

Time and Method of Application

For most effective use of the nitrogen in manure it should be applied in the spring and covered with soil the same day to prevent loss of ammonia. Immediate covering with soil is estimated to provide 25% more nitrogen to the crop than where the same manure is not covered immediately. Most of the nitrogen loss to the air occurs within the first week after application. Injection of manure between corn rows after seeding, but before the corn is 30 cm high, is one way of preventing nitrogen loss and minimizing the potential for pollution of adjacent streams with phosphate from surface runoff. However phosphate applied after a crop is seeded may not be available to that crop. Phosphate fertilizer requirements should therefore not be adjusted for manure applied after seeding.

Where the manure is applied in the fall more nitrogen is lost (to the air and by leaching) than when spring applied. The nitrogen adjustments should be 50% lower for fall applied manure than for spring-applied manure which is not immediately covered (see table). Phosphate and potash are believed to be equally available from fall- and spring-applied manure.

If manure must be spread in the winter, nitrogen adjustments should be the same as for fall applied. Do not spread manure in winter or early spring on fields that are subject to runoff.

Manure Analysis

The nutrient content of manure varies not only with the type of livestock but with their age, the ration fed, the type of bedding or amount of water added and the method of storing the manure. Chemical analyses will indicate more accurately than this publication the amount of nutrients available for crop production from the particular manure you intend to use, provided a representative sample can be obtained. A manure analysis service is offered through the Department of Land Resource Science, University of Guelph. Samples are analyzed on a cash-with-sample basis. Sample containers are available at County and Regional OMAF offices.

PLANT ANALYSIS

For field crops plant analysis is a useful supplement to soil testing for evaluating fertilizer requirements. In the case of nitrogen it is not very reliable but is of some value. In the case of phosphorus, potassium, magnesium and manganese it is a very useful "second opinion" as it is quite independent of soil testing. For zinc, plant analysis on corn at silking has not been very reliable. For boron and copper we do not have a reliable soil test so plant analysis and visual symptoms are the only methods we have of diagnosing deficiencies.

Sampling Recommendations

The concentration of a nutrient in a plant varies with the stage of development of the plant and from one plant part to another. Therefore, a better interpretation of the nutrient status of a crop can be made if the plant is sampled at a definite stage of growth. The recommended parts and stages of growth are given below for various crops. However, plants showing a suspected nutrient deficiency should be sampled as soon as the symptoms appear, since nutrient accumulation can continue even though the plant is not growing normally. Where possible, sample the same plant part as recommended for the normal time of sampling.

Take samples from at least 50 plants randomly distributed over the area chosen for sampling. Problem areas should be sampled separately. Each sample should contain at least 50 grams fresh weight.

Table 65. Sampling Recommendations for Various Crops

Crop	Stage of Growth	Part of Plant
Alfalfa or other perennial legumes	Late bud stage	Entire plant from mowing height
Corn	Initial silking	Mid 1/3 of ear leaf
Small Grains or Forage Grasses	Early heading	Top two leaves
Soybeans or White Beans	Initial flowering	Top fully developed leaf

Sample Preparation

1. Plant parts contaminated with soil will not provide accurate analyses, particularly for iron and manganese.

2. Avoid contact of samples with galvanized or brass materials or other possible contaminants.

3. Deliver fresh samples directly to laboratory. If samples will be stored or in transit for more than one day they should be dried completely. Air-dry samples, or dry in an oven at temperatures up to 65^0C.

Fee

Analyses available and the charges are listed in Table 61. Make cheque or money order payable to the University of Guelph.

Soil Sample

A soil sample, representative of the area from which the plant sample was selected, should be taken and submitted at the same time as the plant sample. Be sure to keep soil and plant separate.

Mailing Instructions

Complete the plant and soil sample information sheets available at your local OMAF office and package with plant sample, soil sample, and cheque or money order made out to the University of Guelph.

Send to: Soil and Plant Analysis Laboratory
Department of Land Resource Science
University of Guelph
Guelph, Ontario
N1G 2W1

SEWAGE SLUDGE

Sewage sludge is a useful source of nitrogen, phosphorus and organic matter, provided it is low in heavy metals and applied under approved conditions. Consult OMAF Factsheet 541, *Use of Stabilized Sewage Sludge on Agricultural Land*.

SOIL ACIDITY AND LIMING

The pH scale ranging from 0 to 14 is used to indicate acidity and alkalinity. A pH value of 7.0 is neutral; values below 7.0 are acid and those above 7.0 are alkaline. Most field crops grow well in a soil pH range from 6.0 to 8.0.

To correct soil acidity ground limestone should be broadcast and worked into the soil at rates determined by soil test. The accompanying table shows the pH values below which lime is recommended and the pH to which soils are limed. The soil pH is used to determine which soils need to be limed but a separate soil test, the buffer pH, is used to determine the amount of lime required. For any one soil pH value the amount of lime required to raise the pH to the desired level is greater for soils high in clay and organic matter content. Calcitic limestone consists largely of calcium carbonate, and dolomitic limestone is a mixture of both calcium and magnesium carbonates. Dolomitic limestone should be used on soils with a magnesium soil test of 100 or less as it is an excellent source of magnesium for acid soils. On soils with magnesium tests greater than 100, calcitic or dolomitic limestone may be used.

Table 66. Soil Acidity and Liming

Crops and Soil	pH below which lime is recommended	pH to which soil is limed
Field and vegetable crops on mineral soils except those listed below.	6.1	6.5
Corn, gardens, winter rye, flue-cured and burley tobacco on mineral soils	5.6	6.0
Potatoes, grass for seed. All crops on organic soils.	5.1	5.5

Limestone Quality

Two main factors affect the value of limestone for soil application. One of these is the amount of acid a given quantity of limestone will neutralize when it is totally dissolved. This is called the "neutralizing value" and is expressed as a percentage of the neutralizing value of pure calcium carbonate. In general, the higher the calcium and magnesium content of a limestone the higher the neutralizing value.

The second factor which affects the value of limestone as a neutralizer of acidity is the particle size. Limestone rock has much less surface area to react with acid soil than finely powdered limestone and, hence, it neutralizes acidity much more slowly; so slowly that it is of little value.

In order to compare various limestones that are available, some means of combining the neutralizing value and the particle size is needed.

The index which has been developed for use in Ontario is called the "Agricultural Index."

The Agricultural Index

$$\text{The agricultural index} = \frac{\text{neutralizing value} \times \text{fineness rating}}{100}$$

A limestone which will neutralize 90% as much acid as pure calcium carbonate is said to have a neutralizing value of 90. The calculation of a fineness rating is illustrated in the accompanying table.

Table 67. Example Calculation of the Fineness Rating of a Limestone

Particle Size	% of Sample		Effectiveness Factor		
Coarser than no. 10 sieve[1]	10	x	0	=	0
no. 10 to no. 60 sieve	40	x	0.4	=	16
Passing through no. 60 sieve	50	x	1.0	=	50
					66

1 *A no. 10 sieve has wires spaced 2.0 mm, and a no. 60 seive spaced 0.25 mm apart.*

The Agricultural Index can be used to compare the relative value of different limestones for neutralization of soil acidity[1]. If two ground limestones, A and B, have Agricultural Indices of 50 and 80 respectively, the rate of application of limestone A required for a particular soil will be 80/50 x the rate required for limestone B. Limestone A spread on your farm is worth 50/80 x the price of limestone B per tonne.

Recommendations from the Ontario soil test service are based on limestone with an Agricultural Index of 75. If you have a limestone requirement by soil test of 9 t/ha, and your most suitable source of limestone from a quality and price standpoint has an Agricultural Index of 90, you should apply 75/90 x 9 = 7.5 t/ha. In other words, if you know the Agricultural Index, you can calculate a rate of application specifically for limestone of that quality. This can be done using the following equation:

$$\text{Limestone application rate from soil test} \times \frac{75}{\text{Agr. Index of your limestone}} = \text{rate of application of your limestone}$$

1 *The Agricultural Index does not provide information about magnesium content. Dolomitic limestone should be used on soils low in magnesium.*

Lowering Soil pH

On soils with pH values below 7.0 it is possible to lower the pH (make the soil more acid) by adding sulfur or aluminum sulfate, but this is not advisable for field crops as it only hastens the time when lime will be required. If the soil pH is above 7.0 it is not advisable and also usually quite impractical to lower the soil pH because of the very large amounts of sulfur or aluminum sulfate required.

SOIL MAGNESIUM

Magnesium is a plant nutrient which is naturally plentiful in many Ontario soils. Soils with magnesium soil tests below 20 (OMAF soil test) require magnesium application for production of most crops. Very few Ontario soils have magnesium tests below 20. If the soil pH is below 6.0, the most effective means of supplying magnesium is by application of dolomitic lime. If the pH is above 6.0, magnesium can be supplied by either magnesium sulfate or sulfate of potash magnesia, which is a mixture of sulfate of potash and magnesium sulfate. These latter sources of magnesium are usually quite expensive.

Potassium competes with magnesium for uptake by crops, and potash applications can therefore induce or increase magnesium deficiency. For this reason it is important to monitor soil potassium levels and to carefully control potash fertilizer applications on low magnesium soils.

Crops grown on a number of Ontario soils are low in magnesium to an extent that livestock health is affected although the crops themselves do not suffer from magnesium deficiency. In these situations it is usually much less costly to add magnesium to the animal's diet than to add it to the soil. Soil potassium should be closely monitored, however, and potash applications restricted to requirements as measured by soil test.

FERTILIZER MATERIALS

Nitrogen fertilizer materials are available in dry or liquid forms. Although there are some limitations to use of these materials (see below), in most cases the different sources will produce equal yields. The farmer's choice of material should therefore depend on availability, equipment for handling, and cost per kilogram of nitrogen, plus the cost of application.

A farmer should first calculate the cost per kilogram of nitrogen for various sources delivered to his farm. Depending on the rate of application, the cost per hectare can be determined. Add to this the cost of application per hectare before deciding which nitrogen source to use.

Where separate additions of nitrogen are referred to in the recommendations, kilograms of elemental nitrogen (N), not kilograms of materials, are used. The following tables show the percentage of fertilizer nutrient contained in different materials.

Table 68. Fertilizer Materials

Nitrogen Materials	Form	% Nitrogen (N)[1]
Ammonium nitrate	Dry	33 to 34
Urea	Dry	45 to 46
Ammonium sulfate	Dry	20
Aqua ammonia	Liquid[2]	20
Ammonium nitrate-urea	Liquid	28
Ammonium nitrate-urea	Liquid[2]	32
Ammonia-ammonium nitrate-urea	Liquid[2]	41
Ammonia-ammonium nitrate	Liquid[2]	41
Anhydrous ammonia	Liquid[2]	82

Table 68. Fertilizer Materials (Cont'd.)

Phosphate Materials	% Phosphate (P_2O_5)[1]
Single superphosphate	18 to 20
Triple superphosphate	44 to 46
Monoammonium phosphate	50 to 54
Diammonium phosphate (18-46-0)	46

Potash Materials	% Potash (K_2O)[1]
Muriate of potash	60 to 62
Sulfate of potash	50
Sulfate of potash magnesia (11% Mg)	22
Potassium nitrate (13-0-44)	44

1 *Kilograms of N, P_2O_5, or K_2O supplied in 100 kg of material.*

2 *Liquid under pressure.*

TOXICITY OF FERTILIZER MATERIALS

All fertilizer salts are toxic to germinating seeds and to plant roots if applied in sufficient concentration near the seed. Fertilizers vary in toxicity per unit of plant nutrient due to: (1) differences in the amount of salts contained in the fertilizer per unit of plant nutrient, (2) differences in solubility of the salts in the soil, and (3) a few specific materials or elements are particularly toxic (for example, anhydrous ammonia and boron). Phosphate fertilizers are usually low in toxicity because a large portion of the phosphate is precipitated in the soil before it can reach the plant roots. The concentration of phosphorus in soil solution at any one time is very low.

TOXICITY OF COMMON FERTILIZER MATERIALS

Nitrogen Fertilizers

Ammonium nitrate, monoammonium phosphate and ammonium sulphate are similar in toxicity and much safer than anhydrous ammonia, aqua ammonia or urea.
Diammonium phosphate is more toxic than monoammonium phosphate but less toxic than urea. More care should be taken, particularly with sensitive seeds and on coarse-textured soil (sand and sandy loam), than is required with ammonium nitrate, or monoammonium phosphate.

Because anhydrous ammonia and aqua ammonia are extremely toxic fertilizers, they should not be placed near seeds. It is preferable to make pre-plant applications crossways to the direction in which the crop will be planted.

Urea is toxic when banded with or near the seed but is safe when broadcast at rates normally used. Fertilizers containing more than half as much nitrogen as phosphate frequently contain urea.

Phosphate Fertilizers

Most common phosphate fertilizers are not very toxic to seeds and plants and no limit is normally set for the safe rate which may be applied with, or near, the seed of field crops.

Diammonium phosphate is more toxic than other phosphate fertilizer - see above under nitrogen fertilizers.

Potash Fertilizers

Muriate of potash (KCl) is the most common source of potassium in fertilizers, and is less toxic per unit of plant nutrients than most nitrogen fertilizers.

Sulphate of potash (K_2SO_4) is less toxic than muriate of potash.

Sulphate of potash-magnesia has approximately the same toxicity per unit of potassium as muriate of potash.

Potassium nitrate is one of the safer sources of potassium.

Fertilizers Containing Micronutrients

Fertilizers containing micronutrients (boron, copper, iron, manganese or zinc) are more toxic than the same grades without micronutrients and maximum safe rates should be reduced. Boron is particularly toxic.

SECONDARY AND MICRONUTRIENTS

If secondary or micronutrients are proven to be needed (by soil and/or tissue tests) then the most common sources of these are:

Magnesium (Mg)

- Dolomitic Limestone	6-13% Mg
- Epsom Salts (Magnesium sulphate)	9.6% Mg
- Sulphate of Potash Magnesia	11% Mg

Boron (B)

Various boron sources are available	8-21% B

Copper (Cu)

Copper Sulphate	13-52% Cu
Copper Chelates	9-13% Cu
Copper Oxide	60-80% Cu

Manganese (Mn)

Manganese Sulphate	26-28% Mn
Manganese Chelates	9-12% Mn

Molybdenum (Mo)

Sodium Molybdate	39% Mo

Zinc (Zn)

Zinc Sulphate	36% Zn
Zinc Chelates	9-14% Zn
Zinc Oxide	78-80% Zn

Various fertilizer companies have available, in addition to the above micronutrient sources, premixes containing one or more of the above micronutrients.

Individual Factsheets are available on some of these micronutrients. For a list of these see Publications section.

Guidelines for Safe Rates of Nutrients Applied at Seeding

Fertilizer toxicity varies widely, depending on the amount of soil moisture. To insure completely safe rates of banded fertilizer for all seeding conditions would require extremely low rates of application. The maximum safe rates suggested here will probably reduce or delay germination, or retard growth in up to 10% of the cases where they are used. In most cases, it is advisable to use lower rates of fertilizer at seeding than those listed in the following table. If fertilizer requirements are high, it may be better to broadcast most of the fertilizer required and to band only a small portion at seeding. Fertilizers containing the micronutrients boron, copper, iron, manganese and zinc are more toxic, and the safe rates recommended will be lower than those shown in this table.

Table 69. Maximum Safe Rates of Nutrients

SPRING OATS OR BARLEY (fertilizer with the seed)	
Sands and Sandy Loam Soils	35 kg nitrogen or 55 kg (nitrogen + potash) per hectare. If **diammonium phosphate** (18-46-0) is the N source, 20 kg nitrogen or 35 kg (nitrogen + potash) per hectare. If **urea** is the N source, 10 kg nitrogen or 30 kg (nitrogen + potash) per hectare[1].
Loams, Silt or Clay Loams	45 kg nitrogen or 70 kg (nitrogen + potash) per hectare. If **diammonium phosphate** (18-46-0) is the N source, 30 kg nitrogen 55 kg (nitrogen + potash) per hectare. If **urea** is the N source, 10 kg nitrogen or 30 kg (nitrogen + potash) per hectare[1].
WINTER WHEAT OR BARLEY (fertilizer with the seed)	
All Soils	15 kg nitrogen or 30 kg (nitrogen + potash) per hectare. **Diammonium phosphate** (18-46-0) or **urea** should not be drilled with the seed of fall-seeded cereals[1].
CORN (fertilizer with the seed)	
All Soils	7 kg (nitrogen + potash) per hectare in one metre rows. **Diammonium phosphate** or **urea** should not be applied with the seed of corn. At row widths other than one metre, the rate may be adjusted to provide the same maximum concentration in the row (in 50 cm rows the safe rate = 100/50 x 7 = 14 kg (nitrogen + potash) per hectare).
CORN (fertilizer banded 5 cm to the side and 5 cm below the seed)	
All Soils	60 kg nitrogen or 90 kg (nitrogen + potash) per hectare. If **urea** is the N source, 30 kg nitrogen or 60 kg (nitrogen + potash) per hectare. At row widths other than one metre, the rate may be adjusted to provide the same maximum concentration in the row (in 50 cm rows the safe rate = 100/50 x 60 = 120 kg N per hectare).

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Table 69. Maximum Safe Rates of Nutrients (Cont'd.)

FLAX AND CANOLA (no fertilizer with seed)	
All soils	Rates recommended are normally safe when broadcast.
PEAS, BEANS AND SOYBEANS (no fertilizer with seed)	
All Soils	**(fertilizer banded 5 cm to the side and 5 cm below the seed)** 30 kg nitrogen or 90 kg (nitrogen + potash) per hectare. Rates recommended are normally safe when broadcast.

1 *Fertilizers containing more than half as much nitrogen as phosphate (e.g. 16-16-16) frequently contain urea. Note that fertilizers containing urea are not suitable for banding at seeding in many cases.*

GENERAL INFORMATION ON PESTICIDE USAGE

Brands of a pesticide from different companies often have different concentrations of the same chemical in them. Consequently, if you use one with a concentration different from that listed in the recommendations in this publication, you will need to adjust the rate of application so that you will be applying the same amount of actual chemical (active ingredient).

PRECAUTIONS WITH PESTICIDES

Read the following points before using any pesticides:

1. Always read the label before opening pesticide containers and follow all precautions and directions.

2. Never smoke, chew tobacco, or eat while handling or applying pesticides. DO NOT carry such items in clothes used for spraying.

3. Always wear neoprene gloves to handle the concentrate. Wear a mask to reduce pesticide inhalation especially when handling dusty formulations or volatile concentrates. Avoid inhaling spray droplets, dust or fumes by wearing a mask.

4. Avoid spilling pesticides on skin or clothing.

5. Wear freshly laundered clothes each day.

6. Avoid contamination of water supplies, wells, ponds, streams, etc. with pesticides when filling or flushing out spray equipment. Never fill a sprayer directly from a stream or pond, unless the unit is equipped with an anti-backflow device to prevent siphoning.

If Accidents Occur

1. If an accident occurs, remove contaminated clothing immediately, and wash contaminated skin thoroughly with soap and water. Wash clothing before reuse.

2. If clothing becomes wet with a pesticide, when spraying, remove it immediately. When the spray operation is complete, remove contaminated clothes, have a bath or shower and put on freshly laundered clothing.

3. Clean up any pesticide spills immediately. Use dry soil, sawdust or other absorbent material to remove excess liquid. If the spill is major, contact the nearest office of the Pesticide Control Service for advice (see Ontario Ministry of the Environment Pesticides Control Field Offices).

4. If symptoms of illness occur during or shortly after handling or applying a pesticide, get the patient to a hospital immediately. (See Emergency Procedures for Pesticide Poisoning, inside front cover).

5. If a well becomes contaminated, follow clean up instructions in OMAF Factsheet, *Pesticide Contamination of Farm Water Supplies*, Agdex 607.

Special Instructions

It should be emphasized that all pesticides are toxic and must be handled safely. In addition a number of pesticides (insecticides, fungicides and herbicides) have major deficiencies in their toxicological information because of the many tests that were conducted by Industrial Biotest Laboratory (IBT), some of which were invalid. Replacement studies are currently being conducted by the respective registrants. Those handling and applying these chemicals must pay special attention to the precautions outlined above.

At the time of publication, pesticides included in this publication requiring additional studies are as follows:

CSA Common Name	Trade Name
disulfoton	Di-Syston
endosulfan	Thiodan, Endosulfan

Storage

1. **General Storage:**

   The Ontario Pesticides Act and Regulation 751 requires that all pesticides be kept out of the reach of children, irresponsible persons, pets and livestock. They should be stored in a locked facility away from food for humans and feed for animals. Herbicides should be stored separately from other pesticides to avoid possible contamination.

   Special Storage:

   Schedule 1, 2 and 5 - pesticides must be stored in a storage facility which is ventilated to the outside atmosphere. A placard bearing the words "CHEMICAL STORAGE WARNING - AUTHORIZED PERSONNEL ONLY" in black capitals must be affixed to the outside of each entrance. Entry to the storage facility should only be made by the person responsible for the pesticide or with his permission.

2. Always store pesticides in original containers and keep them tightly closed. Never put pesticides in unmarked containers. See also OMAF Factsheet Agdex 607, *Farm Storage of Pesticides*.

Disposal of Pesticide Containers & Contaminated Material

1. Containers from pesticide packages and any paper or other material used to clean up spills should be buried or burned. Make sure that people and animals are kept away from the smoke and that the smoke is not directed toward buildings, highways, roads, or public outdoor areas.

2. Un-rinsed containers can contain as much as 3% of the original formulation. If this amount of toxic pesticide is discarded with the drum it could be dangerous to other people handling it, or to the environment (for example, your water supply). Failure to rinse is also wasteful - why not use that 3% to control the pest!

   Rinse all empty metal or glass containers three times with water and add washings to the spray tank. Or, use a rinsing device. These rinsers can be used to puncture the bottom of a metal or plastic drum, and to rinse the residual left in the container directly into the spray tank. This procedure takes less than a minute and results in a rinsed container. The rinsed containers should be crushed, buried and covered by at least 50 cm of soil, away from any watercourse or water table.

   Rinsers are available from Phillips Farm supplies, 96 Sanford Street, Brighton, Ontario, K0K 1H0, telephone (613) 475-2040.

Protective Clothing when Using Pesticides Outdoors

1. When measuring and mixing pesticides, wear neoprene or rubber gloves, rubber boots, a protective apron or coveralls, and protective eyeshields.

2. Disposable gloves, aprons, overalls and hat covers are available at reasonable prices from the major safety supply companies.

3. Wash all protective clothing after use.

4. Wear a chemical cartridge respirator with a dual chemical cartridge when mixing or applying pesticides. Consult Table 66 for proper selection. Never interchange components.

Table 70. Dual Chemical Cartridge Respirators Recommended for Outdoor Protection from Pesticides (Listed in Numerical Order According to NIOSH Approval Numbers)

NIOSH Approval Numbers	Approval Issued To	Respirator No. and Description	Component Numbers	Available From
TC-23C-54	Willson	112115 (2 sizes) Half Face	R21 Cartridges R15 filters	Safety Supply Canada, Toronto
TC-23C-74	Norton	7549L 7549M 7549S (3 sizes) Half Face	N7500-21 Cartridges N7500-23 Filters N750-27 Filter Cover	Siebe-Norton Inc. Toronto, Ontario
TC-23C-78	3M	Powered Air Purifier (pesticide) White Cap Helmet Full-Face	Cartridges Filters and Hood and Vest Kit	Safety Supply Canada, Toronto
TC-23C-106	American Optical	R4058 R5058 R6058 Half Face (3 sizes)	R58A Filter/ Cartridges	AO Safety Products Div., of AOCO, Toronto
TC-23C-117	Scott	Scott Respirator 64-OVP Half-face (3 sizes)	642-OV Cartridges 642-F Filters	Safety Supply Canada, Toronto
TC-23C-123	3M	8751 Half-face	Pre-filter 8752 Retainer 8733	Safety Supply Canada Toronto
TC-23C-124	Safety House	236-G100-F-104 Half Face	G100 Cartridges F104 Filters	Safety House of Canada, Toronto

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Table 70. (Cont'd.) **Dual Chemical Cartridge Respirators Recommended for Outdoor Protection from Pesticides (Listed in Numerical Order According to NIOSH Approval Numbers)**

NIOSH Approval Numbers	Approval Issued To	Respirator No. and Description	Component Numbers	Available From
TC-23C-133	Willson	162115 172115 Full Face	R15 Filters R21 OV Cartridges	Safety Supply Canada Toronto
TC-23C-148	MSA	460560 (3 sizes) Full-face	464025 Combination Cartridges	MSA of Canada, Downsview
TC-23C-178	Norton	75BP 49L 75BP 49M (2 sizes) Full Face	N-7500-21 Cartridges N-7500-23 Filters Back-pack	Siebe-Norton Inc. Toronto, Ontario
TC-23C-190	Norton	7649L 7649M 7649S Silicone Full-face (3 sizes)	N-7500-21 Cartridges N-7500-23 Filters	Siebe-Norton Inc. Toronto, Ontario
TC-23C-202	H.S. Cover (York)	MY 1482 C	100 Cartridges 104 Filters	Levitt-Safety Ltd., Toronto
TC-23C-224	Scott	Scott Respirator 65-OVP Full-face (2 sizes)	642-OV Cartridges 642-F Filters	Safety Supply Canada, Toronto
TC-23C-238	American Optical	R7058 Full-face	R58A Filter/ Cartridges	AO Safety Products Div., of AOCO, Toronto
TC-23C-281	American Optical	R4563 R5563 R6563 (3 sizes)	R563A/Filter Cartridges	AO Safety Products Div., of AOCO, Toronto
TC-23C-282	American Optical	R7563 Full-face	R563A Filter Cartridges	AO Safety Products Div., of AOCO, Toronto

NIOSH Approval Numbers	Approval Issued To	Respirator No. and Description	Component Numbers	Available From
TC-23C-323	Survivair	2131-00 2231-00 2331-00 (sizes)	1001-00 Cartridge 1030-00 Filters	Levitt-Safety Ltd., Toronto
TC-23C-374	Willson	3021155 Breathing Assist Respirator	R15 Filters R21 OV Cartridges	Safety Supply Canada Toronto
TC-23C-375	Willson	322115 Breathing Assist Respirator	R15 Filters R21 OV Cartridges	Safety Supply Canada Toronto

Additional information on protective equipment may be found in Personal Protective Equipment for Pesticide Users, available at offices of the Pesticide Control Service, your pesticide dealer, and offices of the Ontario Ministry of Agriculture and Food.

SPRAYERS

Herbicide sprayers, capable of delivering sufficient litres per hectare for adequate coverage, are satisfactory for applying emulsion-type insecticides. However, if 2,4-D or related herbicides have been used in them, such sprayers will have to be cleaned thoroughly or foliage is apt to be damaged. The detergent recommended should contain ammonia for best results.

For applying the wettable powder formulations, a high-capacity (450 L/ha), high-pressure piston pump sprayer with an agitator, is recommended. Keep in mind that the higher the pressure the greater the danger of drift to other crops.

Calibrate your sprayer at least twice during the growing season. The wear on nozzles and other parts will alter the amount of spray delivered at the usual speed and pressure.

For information on calibration, see the current OMAF Publication 75, *Guide to Chemical Weed Control.*

APPLICATION BY AIRPLANES OR HELICOPTERS

Aerial applicators must be licensed by the Ontario Ministry of the Environment to apply pesticides. In addition, permits are required from the Ontario Ministry of the Environment under the authority of The Pesticides Act for the application of Schedule 1 and 5 pesticides, and Schedule 2 hormone-type herbicides. The area will be inspected by ministry personnel to ensure safety of application.

It is an offense under the Federal Pest Control Product Act to use a control product under unsafe conditions. Precautionary practices must be heeded at all times to prevent drift. Extra precautions should be taken when using insecticides applied by air, especially those known to be toxic to honeybees, e.g. Sevin (carbaryl.)

Applications should not be made if the wind is blowing. Some drift occurs even on the stillest day and to keep it to a minimum, apply pesticides in the evening or early morning.

Be sure that the product to be used is specified, along with rate of application, in the contract.

PESTICIDE DRIFT

Pesticide drift can leave unwanted residues on adjacent crops, be a hazard to people and livestock nearby, or reduce the amount of material in the target area as to be ineffective. Those applying pesticides should make every effort to minimize or prevent pesticide spray drift by paying attention to:

1. correct calibration and maintenance of spray equipment;

2. correct operation of the equipment;

3. being aware of the toxicity of the pesticide in use; and

4. being aware of the weather conditions.

For more information consult OMAF Factsheet, *Pesticide Drift*, Agdex 607, or Canadex 607, *Pesticides: Effects of Drift and Droplet Size.*

PROTECT HONEYBEES

Because bees may be killed, do not apply insecticides that are toxic to bees (see list and remarks, in Table 69) on crops or wild plants that are in bloom. Sevin (carbaryl) is extremely toxic to honeybees. If insect control is necessary while crops are in bloom or corn is shedding pollen, spray only in the evening or in the early morning when bees are not in the field. Do not spray when the wind will carry the insecticide to adjacent bee pastures or into the general area of apiaries.

> WHEN PLANNING TO APPLY A PESTICIDE, ADVISE LOCAL BEEKEEPERS SO THEY HAVE AN OPPORTUNITY TO MOVE COLONIES OUT OF THE DANGER AREA. YOUR LOCAL AGRICULTURAL REPRESENTATIVE HAS A LISTING OF THE BEEKEEPERS IN YOUR AREA.

SEED TREATMENTS

Seed dressings or treatments are poisonous to man and livestock. Do not inhale the fumes or dust when treating or handling treated seed. Wash all residues of these chemicals from the skin after seed treatment is completed. Chemically treated seed is poisonous. Never feed surplus seed to livestock. Destroy all bags that have held treated seed as recommended in the container disposal section above.

RESIDUES ON CROPS TO BE HARVESTED, FED OR GRAZED

Certain pesticide residues disappear quickly after application; others persist in poisonous form for much longer periods. When crops with persistent residues are fed to livestock the poisons tend to accumulate in the body fat and milking cows will excrete them, or their metabolic products in the milk. Young calves, heifers, and dry cows will store these in body fat and secrete them when they freshen months later. Do not use residues from Thiodan-treated crops for bedding. To avoid residue problems, use (1) the proper chemical, (2) the recommended dosage, and (3) observe the proper interval to harvest.

REENTRY INTO TREATED AREAS

Pesticide poisoning may occur where workers enter fields too soon after pesticides have been applied. Such poisoning can result from handling treated plants or from inhalation of pesticide vapors.

The pesticides listed below are those for which a specific minimum interval must be observed from the time of application to the time of working in the crop. For some pesticides, e.g. parathion, the label carries a warning regarding working in treated crops. **Follow these recommendations.** Where no label warnings are provided, the following minimum intervals are recommended. Minimum reentry time of 24 hours is indicated thus^{+}. Minimum reentry time of 48 hours is indicated thus^{+}

24 Hours	48 Hours
$^{+}$ Lannate	$^{+}$ Guthion
	$^{+}$ Furadan

INSECTICIDE NOTES

Relative Toxicity of Crop Insecticides to Man

Extremely Toxic

Amaze (isofenphos)
Birlane (chlorfenvinphos)
Counter (terbufos)
Dasanit (fensulfothion)
Di-Syston (disulfoton)
Dyfonate (fonofos)
Furadan (carbofuran)
Guthion (azinphos-methyl)
Lannate (methomyl)
Thimet (phorate)

These pesticides are dangerous through inhalation, skin contact, or if taken by mouth. A few grams can be fatal. Wear protective clothing (see Precautions with Pesticides), avoid mixing in windy areas, dispose of containers properly (see Precautions with Pesticides) and always wash and change clothing immediately after use.

Moderately toxic

Ambush (permethrin)
Basudin (diazinon)
Captan* (captan)
Cygon (dimethoate)
Imidan (phosmet)
Lorsban (chlorpyrifos)
Thiodan (endosulfan)

These pesticides are dangerous if handled carelessly. Caution is required to ensure that they are not taken internally or allowed to contact bare skin. Wear protective clothing including respirator and goggles when mixing or working with them. Avoid breathing the vapors. Wash and remove clothing after applying these materials. Triple rinse and dispose of containers properly (see Precautions with Pesticides).

* Current studies indicate that captan requires special handling procedures as outlined on the label. Therefore follow directions closely.

Pesticides listed in this publication and not appearing on this list have lower toxicities and should be handled with all precautions listed on the label. Even the most toxic pesticides can be used safely by following all the directions and precautions for proper use as listed on the product label.

Blood Tests for Those Applying Pesticides

Organophosphorus and carbamate pesticides are capable of inactivating and depressing the serum and red blood cholinesterase levels. If the activity of cholinesterase falls below a critical level, human poisoning can result as exhibited by fatigue, dizziness, nausea, trembling, blurred vision, difficulty in breathing and other symptoms. For those working outdoors and applying these groups of pesticides, it is strongly recommended that cholinesterase levels be checked by your family doctor. To be of value the tests should be commenced prior to using these pesticides and not after applications have commenced because the normal level per individual can vary considerably making it difficult to assess the degree of suppression. In this publication the primary insecticides of concern are: Basudin (diazinon), Birlane (chlorfenvinphos), Counter (terbufos), Cygon (dimethoate), Dasanit (fensulfothion), Di-syston (disulfoton), Dyfonate (fonofos), Furadan (carbofuran), Guthion (azinphos-methyl), Imidan (phosmet), Lannate (methomyl), Lorsban (chlorpyrifos), Thimet (phorate), and Thiodan (endosulfan).

Formulations Pesticides may be in either liquid or solid form.

Liquids	Su	-	Suspension
	E or EC or C	-	Emulsifiable Concentrates
	F	-	Flowable
	L	-	Liquid
	LC	-	Liquid Concentrate
	S	-	Sprayable
	SC	-	Sprayable Concentrate
Solids	WP	-	Wettable Powder
	G	-	Granular
	P	-	Powder
	SP	-	Soluble Powder

Table 71. The Addresses and Phone Numbers of Companies Supplying Insecticides

Distributor	Address	Phone
Bartlett	Box 490, Beamsville, Ont. L0P 1B0	(416) 563-8261
Chipman	P.O. Box 9100, Stoney Creek, Ont. L8G 3Z1	(416) 643-4123
Niagara	1274 Plains Rd. E., Burlington, Ont. L7R 3Z1	(416) 634-2355
Pfizer	1 Wilton Grove Rd., Box 2005, London, Ont. N6A 4C6	(519) 681-2173
UCO and IPCO	Suite 801, 151 City Centre Drive, Mississauga, Ont. L5A 3A1	(416) 270-0703
Green Cross	6860 Century Ave., Mississauga, Ont. L5N 2W3	(416) 821-4430

Table 72. Fungicides for Field Crops

Active Ingredient	Trade Name		% Active Ingredient
SEED TREATMENTS			
metiram	Polyram - Diazinon Dust		7
	Polyram 7		7
	Polyram liquid		22.5
captan	Co-op D-L+C		15
	Pfizer D-L-C		15
	R-3 (D-L-C)		33.5
	Captan Flowable		30
	Captan 30 - Methoxychlor 3 (flowable)		30
	Gammasan		10
	Drillbox Lindasan		10
thiram	Thiram 75% D		75
	Vitavax Dual Powder		28.9
	Vitavax Powder		38.8
	Vitaflo-280		13.2
maneb	Agrox Flowable		25
	Agrox N-M		50
	Co-op N-M Drill Box		50
	Mergamma N-M		37.5
carbathiin	Vitaflo-280		14.9
	Vitaflo-250		25.3
	Vitavax Dual Powder		20.0
	Vitavax Powder		26.7
TCMTB	Busan 30		30
Captan + Thiophanate-methyl + Diazinon	DCT	Captan	18
		Thiophanate-methyl	14
		Diazinon	6
FOLIAR SPRAYS			
benomyl	Benlate 50 W		50
dichloran	Botran 75 W		75
thiophanate-methyl	Easout 70 W		70
chlorothalonil	Bravo 500 F		40.4
iprodione	Rovral 50W		50

Table 73. Insecticide Notes

	Insecticide Classification	Formulation	Days to Harvest	Relative Toxicities[1]	Aerial Application	Distributors	Use and Remarks
Amaze (isofenphos)	organo phosphorus	20C	planting Time only	Extremely Toxic	No	Green Cross	Corn
Ambush (permethrin)	pyrethroid	500 EC	Not after 5-leaf stage	Moderately toxic	No	Chipman UCO	Corn
Basudin (diazinon)	organo phosphorus	50 W	7	Moderately toxic	Yes	Chipman Green Cross Niagara Pfizer	Alfalfa, corn, field beans, peas. Toxic to bees.
Birlane (chlorfenvinphos)	organo phosphorus	10 G	planting time only	Extremely toxic	No	Shell Pfizer, UCO	Corn
Counter (terbufos)	organo phosphorus	15 G	planting time only	Extremely toxic	No	Pfizer	Corn
Cygon (dimethoate)	organo phosphorus	480 E	2 Alfalfa 7 Beans	Moderately toxic	Yes	Bartlett Chipman Green Cross Niagara Pfizer, UCO	Alfalfa, field beans. Toxic to bees.
Dasanit (fensulfothion)	organo phosphorus	15 G	planting time only	Extremely toxic	No	Green Cross Niagara Pfizer, UCO	Corn

Di-Syston (disulfoton)	organo phosphorus	15 G 720 LC	planting time only	Extremely toxic	No	Green Cross	Corn
Dyfonate (fonofos)	organo phosphorus	20 G	planting time only	Extremely toxic	No	Chipman UCO	Corn
Dylox (trichlorfan)	organo phosphorus	80% SP 420 Liquid	21	Lower Toxicity	Yes	Agrospray Green Cross Niagara, UCO	Cereals Relatively safe to bees.
Furadan (carbofuran)	carbamate	10 G 480 F	planting time only 7	Extremely toxic	Yes, Permit Required	Bartlett Green Cross Niagara	Corn, alfalfa. Toxic to bees.
Guthion (azinphos-methyl)	organo phosphorus	240 SC 50 W	3 Beans 21 Alfalfa 30 Grain	Extremely toxic	Yes, Permit Required	Bartlett Chipman Green Cross Niagara Pfizer	Field beans, soybeans. Toxic to bees.
Imidan (phosmet)	organo phosphorus	50 W	7	Moderately toxic	Yes	Chipman	Alfalfa, Toxic to bees.
Lannate (methomyl)	carbamate	L	21	Extremely toxic	Yes	Pfizer Niagara	Grain
Lorsban (chlorpyrifos)	organo phosphorus	4 G 25 WP 15 G	100	Moderately toxic	Yes Permit Required	King Grain Pfizer	Corn

Table 73. Insecticide Notes (Cont'd)

	Insecticide Classification	Formulation	Days to Harvest	Relative Toxicities[1]	Aerial Application	Distributors	Use and Remarks
Malathion	organo phosphorus	500 EC 25 W	7	Lower toxicity	Yes	Bartlett Chipman Green Cross Niagara Pfizer UCO	Alfalfa, grain crops, field beans, soybeans, Toxic to bees. Less effective below 16°C
Methoxychlor	organo chlorine	240 EC 50 W	7	Lower toxicity	Yes	Bartlett Chipman Niagara UCO	Alfalfa, grain crops, Relatively safe to bees.
Sevin (carbaryl)	carbamate	50 W 80 S 85 W 480 Su	1 Corn 3 Pea 14 Grain 1 Alfalfa 1 Bean	Lower toxicity	Yes	Bartlett Chipman Niagara Pfizer UCO Green Cross	Alfalfa, corn, field beans, soybeans, grain crops. Extremely toxic to bees.
Thimet (phorate)	organo phosphorus	15 G	planting time only	Extremely toxic	No	Green Cross Pfizer UCO	Corn
Thiodan (endosulfan)	organo chlorine	4 EC	7	Moderately toxic	Yes	Chipman Green Cross Pfizer Niagara	Field beans, soybeans, Toxic to bees.
Thuricide and Dipel (Bacillus thuringiensis)	Biological	HPC SC	0	Lower toxicity	Yes	Chipman Niagara	

1 Insecticide Notes.

Western Ontario Offices

County	OMAF Offices		Field Crops Specialists
Essex Kent	46 Fox St., Essex, N8M 2S2 Box 726, 435 Grand Ave. W. Chatham, N7M 5L1	519-776-7361 519-354-2150	Henry Olechowski 519-674-5456 c/o PCAT, Ridgetown N0P 2C0
Lambton Middlesex	Box 730, Petrolia, N0N 1P0 367 Pidout St. N., London N6A 2P2	519-882-0180 519-434-6811	John Schleihauf 519-434-6811 367 Pidout St., London N6A 2P2
Norfolk Elgin	Box 587, Simcoe, N3Y 4N5 594 Talbot St., St. Thomas, N5P 1C7	519-426-7120 519-631-4700	Bruce Archibald 519-426-7120 Box 587, Simcoe, N3Y 4N5
Oxford Brant Wentworth	Box 666, Woodstock, N4S 7Z5 207 Greenwich St., Brantford, N3S 2X7 RR1, Ancaster, L9G 3K9	519-537-6621 519-759-4190 416-527-2995	Harvey Wright 519-824-4120 c/o Crop Science Ext. 2513 University of Guelph, Guelph, N1G 2W1
Huron Perth	Box 159, Clinton, N0M 1L0 Box 398, 413 Hibernia St. Stratford, N5A 6T3	519-482-3428 519-271-0280	Patrick Lynch, 519-271-0280 Box 398, 413 Hibernia St., Stratford, N5A 6T3
Haldimand Niagara, North Niagara, South	Box 120, Cayuga, N0A 1E0 Vineland Station, L0R 2E0 574 South Pelham St., Welland, L3C 3C6	416-772-3381 416-562-4142 416-732-7552	K. Pereza 416-527-2995 R.R.1, Ancaster, L9G 3K9
Wellington Waterloo Halton	Box 159, Fergus, N1M 2W7 270 Weber St. N., Waterloo N2J 3H8 17 Wilson Dr., Milton, L9T 3J7	519-846-5371 519-884-5390 416-878-2314	Hugh Martin 519-824-4120 c/o Land Resource Science Ext.2454 University of Guelph, Guelph, N1G 2W1
Bruce Grey Dufferin	Box 1330, Walkerton, N0G 2V0 181 Toronto St. S., Markdale, N0C 1H0 RR4, Orangeville, L9W 2Z1	519-881-3301 519-986-2040 519-941-3830	Joan MacDonald 519-881-3301 Box 1330, Walkerton, N0G 2V0
Simcoe, North Simcoe, South Peel York	Box 340, Elmvale, L0L 1P0 Box 370, Alliston, L0M 1A0 3 Elizabeth St. S., Brampton, L6Y 1P7 Newmarket Plaza, Newmarket L3Y 2N1	705-322-2231 705-435-5521 416-451-5474 416-895-4519	Dave Morris 705-435-5521 Box 370, Alliston, L0M 1A0

Seeds and Weeds Specialists

Southern Ontario	R.D. McLaren, Crop Science Department, University of Guelph, Guelph, NIG 2W1 - 519-824-4120, Ext. 2513
Northern Ontario	Walker Riley, 222 McIntyre St. W., North Bay, P1B 2Y8 - 705-474-3050

Insect and Disease Specialists

Insects	K. Bereza, R.R. 1, Ancaster, L9G 3K9 - 416-527-2995
Diseases	C. Hunter, Research Station, P.O. Box 587, Simcoe, N3Y 4N5 - 519-426-7120

Tobacco Specialists

M.C. Watson, Research Station, Box 186, Delhi, N4B 2W9 -
N.W. Sheldow 519-582-1950

Eastern Ontario Offices

County	OMAF Offices		Field Crops Specialists
Ontario	Box 309, Uxbridge, L0C 1K0	416-852-3328	
Victoria	322 Kent St. W., Lindsay, K9V 2Y9	705-324-6125	
Durham	234 King St. E., Bowmanville, L1C 1P5	416-623-3348	Neil Moore 705-324-6125 322 Kent St. W., Lindsay, K9V 2Y9
Peterborough	55 George St. N., Peterborough, K9J 3G7	705-745-2403	
Northumberland	Box 820, Brighton, K0K 1H0	613-475-1630	
Hastings	Box 340, Stirling, K0K 3E0	613-395-3393	Howard Lang 613-476-3224 Box 470, Picton, K0K 2T0
Lennox & Addington	41 Dundas St. W., Napanee, K7R 1Z5	613-354-3371	
Prince Edward	Box 470, Picton, K0K 2T0	613-476-3224	
Frontenac	Box 651, 1055 Princess St., Kingston, K7L 1H3	613-544-1995	
Leeds	Box 635, Brockville, K6V 5V8	613-342-2124	
Grenville	Box 2004, Kemptville, K0G 1J0	613-258-3411	Dorothy Haley
Dundas	Box 488, Winchester, K0C 2K0	613-774-2313	Box 2004, Kemptville 613-258-3411
Stormont	Box 655, 109-11th St. W., Cornwall, K6H 5T3	613-933-1581	K0G 1J0
Lanark	P.O. Box 37, Perth, K7H 3E2	613-267-4200	
Renfrew	315 Raglan St. S., Renfrew, K7V 1P6	613-432-4841	Gerald Winnicki 613-258-3411 Box 2004, Kemptville
Carleton	26 Thorncliffe Place, Nepean, K2H 6L2	613-828-9167	K0G 1J0
Prescott	Box 110, Plantagenet, K0B 1L0	613-673-5115	
Russell	Box 540, 666 Notre Dame St. Embrun, K0A 1W0	613-443-3391	P.F. Beaudin, 613-673-5115 Box 110
Glengarry	Box 579, Alexandria, K0C 1A0	613-525-1046	Plantagenet, K0B 1L0

Northern Ontario District Offices

County	OMAF Offices		Field Crops Specialists	
Algoma	1496 Wellington St. E. Sault Ste. Marie, P6A 2R1	705-253-1161		
Cochrane, North	Experimental Farm, Kapuskasing, P5N 2X9	705-335-5828		
Cochrane, South	Box 608, Matheson, P0K 1N0	705-273-2509		
Kenora	Ontario Government Building, Box 3000, Dryden, P8N 3B3	807-223-2415		
Manitoulin	Box 328, Gore Bay, P0P 1H0	705-282-2043		
Muskoka & Parry Sound	Box 130, Huntsville, P0A 1K0	705-789-5491	Walker Riley 222 McIntyre St. W. North Bay P1B 2Y8	705-474-3050
Nipissing	222 McIntyre St. W., North Bay, P1B 2Y8	705-474-3050		
Rainy River	Front St., Emo, P0W 1E0	807-482-2310		
Sudbury	1414 LaSalle Blvd., Sudbury, P3A 1Z0	705-566-1630		
Timiskaming	Box "C," New Liskeard, P0J 1P0	705-647-6701		
Thunder Bay	Ontario Government Building 435 James St. S. Thunder Bay, P7E 6E3	807-475-1631		

ONTARIO MINISTRY OF THE ENVIRONMENT - PESTICIDES CONTROL FIELD OFFICES

Counties	Field Offices	Telephone
Southwestern Region Elgin, Middlesex, Oxford	D.C. Morrow & W. Lampman 985 Adelaide Street South, London N6E 1V3	519-681-3600
Essex, Kent, Lambton	H.E. Collins P.O. Box 237, 435 Grand Ave. W. Chatham N7M 5K3	519-352-5107
Bruce Grey, Huron, Perth	B.T. Lobb 20 King Street P.O. Box 688, Ont. Ministry of Agr. & Food Bldg. Clinton N0M 1L0	519-482-3248
West Central Region		
Haldimand, Norfolk, Niagara, Hamilton, Wentworth	J. Percy Ont. Gov't. Bldg., 119 King St. W. Hamilton L8N 3Z9	416-521-7640
Dufferin, Wellington, Waterloo, Brant	R. Miller Ont. Gov't. Bldg., 119 King St. W. Hamilton L8N 3Z9	416-521-7640
Central Region		
Halton, Peel, York, Durham, Toronto	T. O'Neill & D. Trenholm 150 Ferrand Drive, Suite 700, Don Mills M3C 3C3	416-424-3000
Peterborough, Victoria, Haliburton, Northumberland	A.G. Carpentier 139 George Street N., Peterborough K9J 3G6	705-743-2972
Simcoe, Muskoka	W. Cowie 12 Fairview Road, Barrie L4N 4P3	705-726-1730

Southeastern Region		
Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville	D.A. Raddon 133 Dalton St., Box 890, Kingston K7Z 4X6	613-549-4000
Prescott & Russell, Renfrew, Stormont, Dundas & Glengarry, Ottawa-Carleton, Lanark	R.P. Cameron 2378 Holly Lane, Suite 204, Ottawa K1V 7P1	613-521-3450
Northeastern Region		
Manitoulin, Nipissing, Parry Sound, Sudbury	D.J. Mewett Northgate Shopping Centre, 1500 Fisher St., North Bay P1B 2H3	705-476-1001
Cochrane, Timiskaming, Algoma	P. McCubbin 83 Algonquin Blvd. W., Timmins P4N 2R4 Sault Ste. Marie	705-264-9474 705-949-4640
Northwestern Region		
Kenora, Rainy River, Thunder Bay	G.R. Cammond Ontario Government Building, 435 James St. S. Thunder Bay "F" P7E 6F3	807-475-1305
Head Office	Commercial & Agricultural Chemicals Section 135 St. Clair Avenue W., Suite 100 Toronto, Ontario M4V 1M2	416-965-2401

PUBLICATIONS - The following publications are available from any of the Pesticide Control Field offices or from the Head Office of the Ministry of the Environment

Personal Protective Equipment for Pesticide Users
Chemical Safety Handbook
Pesticides Act and Regulations
Chemical-Storage Signs

POISON CONTROL SPECIALISTS

The Occupational Health and Safety Division, Ministry of Labour, 400 University Ave., Toronto, M7A 1T7 has physicians available for consultation on first-aid information and advice. They can be contacted in the following manner:

Between the hours of 8:00 a.m. and 5:00 p.m. Monday to Friday, telephone (416) 965-3610.

During weekends, public holidays and non-office hours telephone (416) 965-1211 and ask for the "on-call" physician.

See inside front cover, **Emergency Procedures for Pesticide Poisoning.**

DISTRIBUTORS OF VARIETIES RECOMMENDED IN PUBLICATION 296

Bishop Farm Seeds Ltd. Box 338, Belleville, Ontario K8N 5A5	613-968-5533
Dekalb Canada Ltd. Box 430, Chatham, Ontario N7M 5K5	519-352-5310
General Seed Co. Box 32, Station E, Hamilton, Ont. L8S 4K9	416-648-6900
King Grain Limited P.O. Box 1088, Chatham, Ontario N7M 5L6	519-354-3210
Maple Leaf Mills Limited P.O. Box 9, Wallaceburg, Ontario N8A 4L5	519-627-1428
Mapleseed Inc. Oakwood, Ontario K0M 2M0	705-786-2020
Northrup King Seeds Ltd. 1250 Franklin Blvd., Box 1207, Cambridge, Ontario N1R 6C9	519-621-0890
Oseco Inc. P.O. Box 219, Brampton, Ontario L6V 2L2	416-846-5080
Oseco Farm Seed Centre 75 Cardigan Street, Guelph, Ont. N1H 3J7	519-822-4800
Otto Pick & Sons Seeds Ltd. Box 126, Richmond Hill, Ontario L4C 4X9	416-884-1147
PAG Seeds Box 490, Princeton, Ontario N0J 1V0	519-458-4336
Pioneer Hi-Bred Ltd. Box 730, Chatham, Ontario N7M 5L1	519-352-6350
Rothwell Seeds Ltd. Box 511, Lindsay, Ontario K9V 4L9	705-324-9591

SeCan*
Suite 512, 885 Meadowlands Dr.,
Ottawa, Ont. K2C 3N2 613-225-6891

Speare Seeds Ltd.
P.O. Box 171, Harriston, Ontario N0G 1Z0 519-338-3840

Stewart Seeds (CIBA-Geigy Seeds Ltd.)
P.O. Box 40, Ailsa Craig, Ontario N0M 1A0 519-293-3211

Tib Szego Associates Ltd.
P.O. Box 366, Lindsay, Ontario K9V 4S3 705-324-0042

United Cooperatives of Ontario
151 City Centre Drive,
Mississauga, Ont. L5A 3A4 416-270-3560

W.G. Thompson & Sons Ltd.
Box 250, Blenheim, Ontario N0P 1A0 519-676-5411

* For more information, contact your local SeCan member.

PUBLICATIONS

Available from your local office of the Ontario Ministry of Agriculture and Food

CORN

Corn Production in Ontario - Publication 13
1984 Ontario Hybrid Corn Performance Trials Report

Factsheets:

111/25	Corn Lodging
111/31	Heat Units for Corn in Southern Ontario
111/61	High Moisture Corn
100/531	Zinc Requirements for Field Crops
111/541	Nitrogen Recommendations for Corn
111/622	European Corn Borer
111/622	Corn Leaf Aphid
111/622	Corn Rootworms
111/622	Potato Stem Borer in Field Corn
111/630	Stunting of Young Corn
111/632	Heat Smut of Corn
111/632	Leaf Diseases of Field Corn
111/685	Bird Damage to Corn
111/736	Harvesting and Storing Quality Grain Corn
111/742	Calibrating Your Corn Planter
111/745	Measuring Corn Harvesting Losses
111/840	Pricing Corn in Ontario
440/60	Moldy Feeds and Swine Diseases
675	Sap Beetles on Raspberries, Tomatoes, Corn

FORAGES

Alfalfa - Publication 59
Pasture Production - Publication 19
Quality Forage for Milk or Beef - Publicatin 54
Annuals for Supplementary Feed - Publication 47
Red Clover for Feed, Seed and Soil - Publication 221

Factsheets:

120/22	Successful Forage Establishment
120/31	Selecting a Perennial Forage
120/52	Quality Hay Crop Silage
120/81	Protein Supplements from Forage Legumes
120/30	Fertilizer Use in Forage Establishment
120/622	European Skipper
120/745	Haying with a Large Round Baler
121/21	Alfalfa Persistence
122/21	Establishment of Bird's-Foot Trefoil
121/21	Stop Alfalfa Winterkill
121/531	Boron Requirements for Alfalfa
121/542	Fertilizer Practices for Alfalfa Production
121/600	Verticillium Wilt of Alfalfa
121/622	Alfalfa Weevil
121/622	Alfalfa Blotch Leafminer
121/622	Potato Leafhopper in Alfalfa
121/736	Determining Moisture Content of Alfalfa Using a Microwave Oven
122/10	Red Clover in Ontario

122/20	Bird's-Foot Trefoil Production
122/22	Establishment of Bird's-Foot Trefoil
122/30	Varieties, Seed and Mixtures of Bird's-Foot Trefoil
136/22	Trefoil Establishment on Roughland Pastures

CEREAL GRAINS

Rid Ontario of Common Barberry and European Buckthorn - Publication 49
Insects in Farm Stored Grain - Publication 229
Smut Diseases of Grain Crops - Publication 524
1983 Regional Test Report Barley, Oats, and Wheat,
Department of Crop Science, University of Guelph

Factsheets:

100/531	Manganese in Soybean and Small Grain Production
110/622	Armyworms
110/632	Cereal Fungus Diseases
110/632	Cereal Virus Diseases
110/717	Grain Aeration
112/10	Winter Wheat in Ontario
112/630	Head Diseases of Winter Wheat
112/600	Leaf Diseases of Winter Wheat
113/632	Oat-Cyst Nematode
114/542	Fertilizing Practices for Growing Barley
114/632	Leaf and Head Diseases of Barley
118/10	Winter Triticale in Ontario

FIELD BEANS

Factsheets:

140/630	Virus Diseases and Bronzing of Field and Snap Beans
142	Growing White Beans in Ontario
142/10	Kidney Beans in Ontario
142/622	White Bean Insects
142/632	Common Blight of Field Beans
142/840	Production & Marketing of White Beans
255/630	Fungal Diseases of Field and Snap Beans

FIELD PEAS

Factsheets:

142/13	Field (Dry) Peas in Ontario

SOYBEANS

Soybean Production in Ontario - Publication 173

Factsheets:

100/531	Manganese in Soybean and Small Grain Production
141/10	Getting into Soybeans - Harvesting, Marketing, Storage and Feeding
141/10	Getting into Soybeans - Planting and Growing the Crop
141/745	Measuring Soybean Harvesting Losses
141/840	Pricing and Marketing Soybeans

CANOLA

149/10	Spring Canola in Ontario

HERBICIDES AND WEEDS

Guide to Chemical Weed Control - Publication 75
Ontario Weeds - Publication 505 Price $2.50

Factsheets:

744	Weed Sprayer Calibration
100/744	Calibration of Flood-Jet Nozzles
607	Pesticide Drift
640	Cocklebur
642	Fall Panicum in Ontario
640	The Annual Nightshades
640	Proso Millet
642	Field Bindweed
642	Nutsedge
642	Jerusalem Artichoke
642	Velvetleaf
642	Pigweeds (Redroot, Green and Smooth)

SOILS

Ontario Soils - Publication 492 - Price $1

Factsheets:

100/516	Tillage for Crop Production on Ontario Soils - Practices
100/536	Tillage Practices for Residue Management and Erosion Control
100/516	Tillage for Crop Production on Ontario Soils - Principles
100/538	Manure for Crop Production
100/540	Foliar and Liquid Fertilizers
534	Soil Acidity and Liming
542	Guidelines for Safe Rates of Nutrients Applied at Seeding
555	Management of Drained Fields
555	Drainage Benefits
553	Maintenance of the Drainage System
540	Chemical and Organic Fertilizers
100/541	How and Where to Use Sewage Sludge in Crop Production
562	Irrigation - Water Supply
572	Soil Erosion - Causes and Effects
573	Control of Soil Erosion
573	Grassed Waterways
573	Gulley Erosion Control
606	Soil Fumigants

PESTICIDE USE

Factsheets:

607	Protective Clothing When Using Pesticides Outdoors
607	Farm Storage of Pesticides
607	Pesticide Contamination of Farm Water Supplies
607	Pesticide Drift
607	Pesticide Container Rinsing

AVAILABLE FROM INFORMATION SERVICES, AGRICULTURE CANADA, OTTAWA, K1A 0C7

Growing Corn - Publication 1025
Growing Soybeans - Publication 1487
Production of Field Peas in Canada - Publication 1710
Growing Flax in Canada - Publication 1577
Growing Buckwheat - Publication 1468
Growing and Using Fababeans - Publication 1540
Sunflower Seed Crops - Publication 1687
Red Clover Production - Publication 1614
Timothy - Publication 1640
Growing and Managing Alfalfa in Canada - Publication 1705
Alsike Clover - Publication 1264
Common Insects of Corn in Eastern Canada - Publication 945
Grain Drying - Publication 1497
Field Sprayers - Publication 1482
Insects and Mites in Farm-Stored Grain - Publication 1595
Blackbirds and the Protection of Field Crops - Publication 1652

AVAILABLE FROM ONTARIO MINISTRY OF THE ENVIRONMENT FIELD OFFICES

Personal Protective Equipment for Pesticide Users
Chemical Safety Handbook
Pesticides Act and Regulations
Chemical Storage Signs
Factsheet - Aluminum Phosphide for Groundhog Control

METRIC EQUIVALENTS

LENGTH

inch	= 2.54 cm - 25.4 mm
foot	= 0.30 m
yard	= 0.91 m
mile	= 1.61 km

AREA

square foot	= 0.09 m^2
square yard	= 0.84 m^2
acre	= 0.40 ha

WEIGHT

ounce	= 28.35 g
pound	= 453.6 g
ton	= 0.91 tonne

VOLUME (dry)

cubic yard	= 0.76 m^3
bushel	= 36.37 L

PRESSURE

pounds per square inch	= 6.90 kPa

VOLUME (liquid)

fluid ounce (Imp.)	= 28.41 mL
pint (Imp.)	= 0.57 L
gallon (Imp.)	= 4.55 L
gallon (U.S.)	= 3.79 L

THE METRIC SYSTEM

Linear Measures (length)

10 millimetres (mm) = 1 centimetre (cm)
100 centimetres (cm) = 1 metre (m)
1000 metres = 1 kilometre (km)

Weight Measures

1000 milligrams (mg) = 1 gram (g)
1000 g = 1 kilogram (kg)
1000 kg = 1 tonne (t)
1 mg/kg = 1 part per million (ppm)

Square Measures (area)

100 m x 100 m = 10,000 m^2 = 1 hectare (ha)
100 ha = 1 square kilometre (km^2)

Cubic Measures (volume)

Dry Measure

1000 cubic millimetres (mm^3) = 1 cubic centimetre (cm^3)
1,000,000 cm^3 = 1 cubic metre (m^3)

Liquid Measure

1000 millilitres (mL) = 1 litre (L)
100 L = 1 hectolitre (hL)

Dry -- Liquid Equivalents

1 cm^3 = 1 mL
1 m^3 = 1000 L

Weight — Volume Equivalents

(1.00 kg) 1000 grams = 1 litre (1.00 L)
(0.50 kg) 500 g = 500 mL (0.50 L)
(0.10 kg) 100 g = 100 mL (0.10 L)
(0.01 kg) 10 g = 10 mL (0.01 L)
(0.001 kg) 1 g = 1 mL (0.001 L)

CONVERSION TABLES — METRIC TO IMPERIAL

(approximate)

Length

1 millimetre (mm)	=	0.04 inch
1 centimetre (cm)	=	0.40 inch
1 metre (m)	=	39.40 inches
1 metre (m)	=	3.28 feet
1 metre (m)	=	1.09 yards
1 kilometre	=	0.62 mile

Area

1 square centimetre (cm^2)	=	0.16 square inch
1 square metre (m^2)	=	10.77 square feet
1 square metre (m^2)	=	1.20 square yards
1 square kilometre (km^2)	=	0.39 square mile
1 hectare (ha)	=	107,636 square feet
1 hectare (ha)	=	2.5 acres

Volume (liquid)

1 millilitre (mL)	=	0.035 fluid ounce
1 litre (L)	=	1.76 pints
1 litre (L)	=	0.88 quart
1 litre (L)	=	0.22 gallon (Imperial)
1 litre (L)	=	0.26 gallon (U.S.)

Volume (dry)

1 cubic centimetre (cm^3) = 0.061 cubic inch
1 cubic metre (m^3) = 1.31 cubic yards
1 cubic metre (m^3) = 35.31 cubic feet
1000 cubic metres (m^3) = 0.81 acre-foot
hectolitre (hL) = 2.8 bushels

Weight

1 gram (g)	=	0.035 ounce
1 kilogram (kg)	=	2.21 pounds
1 tonne (t)	=	1.10 short tons
1 tonne (t)	=	2205 pounds

Speed

1 metre per second	=	3.28 feet per second
1 metre per second	=	2.24 miles per hour
1 kilometre per hour	=	0.62 mile per hour

Pressure

1 kilopascal (kPa) = 0.15 pounds/square inch

Temperature

$^oF = (^oC \times 9/5) + 32$
$^oC = (^oF - 32) \times 5/9$

Proportion

1 litre per hectare	=	14.24 fluid ounces per acre
1 kilogram per hectare	=	14.50 ounces avdp per acre
1 kilogram per square centimetre	=	14.23 pounds per square inch
1 hectolitre per hectare	=	1.10 bushels per acre

Application Rate Conversions (Metric to Imperial — Approximate)

litres per hectare x 0.09	=	gallons per acre
litres per hectare x 0.36	=	quarts per acre
litres per hectare x 0.71	=	pints per acre
millilitres per hectare x 0.015	=	fluid ounces per acre
grams per hectare x 0.015	=	ounces per acre
kilograms per hectare x 0.89	=	pounds per acre
tonnes per hectare x 0.45	=	tons per acre

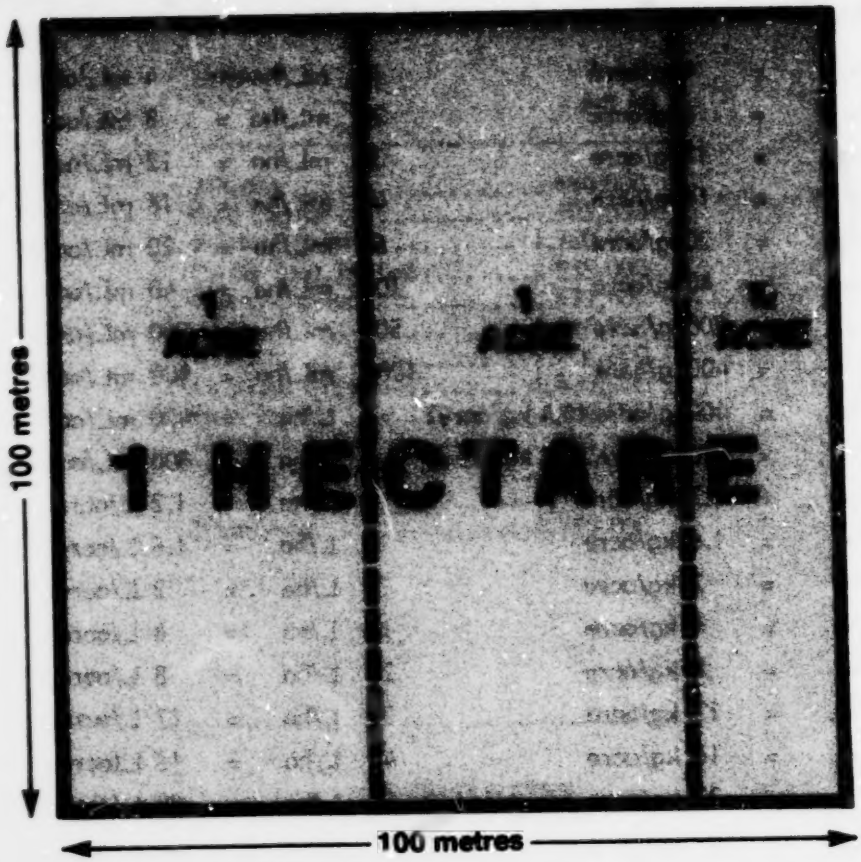
Dry Weight Equivalent

Grams, Kilograms/Hectare		Approximate Ounces, Pounds/Acre
100 grams	=	1-1/2 ounces
200 grams	=	3 ounces
300 grams	=	4-1/4 ounces
500 grams	=	7 ounces
700 grams	=	10 ounces
1.10 kilograms	=	1 pound
1.50 kilograms	=	1-1/4 pounds
2.00 kilograms	=	1-3/4 pounds
2.50 kilograms	=	2-1/4 pounds
3.25 kilograms	=	3 pounds
4.00 kilograms	=	3-1/2 pounds
5.00 kilograms	=	4-1/2 pounds
6.00 kilograms	=	5-1/4 pounds
7.50 kilograms	=	6-3/4 pounds
9.00 kilograms	=	8 pounds
11.00 kilograms	=	10 pounds
13.00 kilograms	=	11-1/2 pounds
15.00 kilograms	=	13-1/2 pounds

Liquid Equivalent

Litres/Hectare		Approximate Gallons/Acre
50	=	5
100	=	10
150	=	15
200	=	20
250	=	25
300	=	30

ACRES BECOME HECTARES



100 m x 100 m = 10,000 m² = 1 hectare (ha)

HECTARES TO ACRES

1 hectare	=	2.5	acres
2 hectares	=	5.0	acres
3 hectares	=	7.4	acres
4 hectares	=	10.0	acres
5 hectares	=	12.4	acres
6 hectares	=	15.0	acres
7 hectares	=	17.3	acres
8 hectares	=	20.0	acres
9 hectares	=	22.2	acres
10 hectares	=	25.0	acres
20 hectares	=	50.0	acres
30 hectares	=	74.0	acres
40 hectares	=	100.0	acres
50 hectares	=	123.5	acres

ACRES TO HECTARES

1 acre	=	0.4	hectares
2 acres	=	0.8	hectares
3 acres	=	1.2	hectares
4 acres	=	1.6	hectares
5 acres	=	2.0	hectares
6 acres	=	2.4	hectares
7 acres	=	2.8	hectares
8 acres	=	3.2	hectares
9 acres	=	3.6	hectares
10 acres	=	4.0	hectares
20 acres	=	8.0	hectares
30 acres	=	12.0	hectares
40 acres	=	16.0	hectares
50 acres	=	20.0	hectares
60 acres	=	24.0	hectares
70 acres	=	28.0	hectares
80 acres	=	32.0	hectares
90 acres	=	36.0	hectares
100 acres	=	40.0	hectares

METRIC APPLICATION RATES WITH AN ACRE PERSPECTIVE

Dry Weight			
10	g/ha	=	4 g/acre
20	g/ha	=	8 g/acre
30	g/ha	=	12 g/acre
40	g/ha	=	16 g/acre
50	g/ha	=	20 g/acre
100	g/ha	=	40 g/acre
500	g/ha	=	200 g/acre
1000	g/ha	=	400 g/acre
1	kg/ha	=	400 g/acre (0.4 kg/acre)
2	kg/ha	=	800 g/acre (0.8 kg/acre)
3	kg/ha	=	1.2 kg/acre
4	kg/ha	=	1.6 kg/acre
5	kg/ha	=	2 kg/acre
10	kg/ha	=	4 kg/acre
20	kg/ha	=	8 kg/acre
30	kg/ha	=	12 kg/acre
40	kg/ha	=	16 kg/acre
50	kg/ha	=	20 kg/acre
100	kg/ha	=	40 kg/acre
500	kg/ha	=	200 kg/acre
1000	kg/ha	=	400 kg/acre
1	tonne/ha	=	400 kg/acre

Liquid Volume			
10	mL/ha	=	4 mL/acre
20	mL/ha	=	8 mL/acre
30	mL/ha	=	12 mL/acre
40	mL/ha	=	16 mL/acre
50	mL/ha	=	20 mL/acre
100	mL/ha	=	40 mL/acre
500	mL/ha	=	200 mL/acre
1000	mL/ha	=	400 mL/acre
1	L/ha	=	400 mL/acre (0.4 L/acre)
2	L/ha	=	800 mL/acre (0.8 L/acre)
3	L/ha	=	1.2 L/acre
4	L/ha	=	1.6 L/acre
5	L/ha	=	2 L/acre
10	L/ha	=	4 L/acre
20	L/ha	=	8 L/acre
30	L/ha	=	12 L/acre
40	L/ha	=	16 L/acre
50	L/ha	=	20 L/acre
100	L/ha	=	40 L/acre
500	L/ha	=	200 L/acre
1000	L/ha	=	400 L/acre

SEEDS PER UNIT OF FORAGE SPECIES

Crop	Seeds per kg
Alfalfa	440,000
Red Clover	605,000
White Clover	1,760,000
Bird's-foot Trefoil	935,000
Sweet Clover	572,000
Alsike	1,540,000
Timothy	2,706,000
Orchard Grass	1,439,000
Bromegrass	300,000
Meadow & Tall Fescue	506,000
Perennial Rye Grass	500,000
Reed Canary Grass	1,173,000
Bluegrass	4,790,000

SEEDING RATES

Crop	kg/ha	
Wheat (Winter & Spring)	100-300	
Oats	55-75	not seeded down
	40-55	seeded down
Barley (Winter & Spring)	80-110	
Rye	70-95	small seeded varieties
	120-160	large seeded varieties
Triticale (OAC Wintri)	75-100	
Corn	11-22	
Beans (White)	40-45	
Soybeans	65-100	
Peas (Field)	130-200	
Buckwheat	55	
Flax (for seed)	40	
Canola	5.5-8	
Sunflower	6-8	
Mustard	8-11	
Turnips	0.6	
Rape (forage)	1.75	in rows
Kale	2.25	in rows
	7	broadcast
Sorghum-sudan grass	13-17	

1984 FIELD CROP RECOMMENDATIONS

Information supplied under the direction of the Ontario Field Crops Research committee, composed of representatives of the following organizations:

Ontario Agricultural College
- University of Guelph

Ontario Ministry of Agriculture and Food
- Colleges of Agricultural Technology:
  - Centralia
  - Kemptville
  - New Liskeard
  - Ridgetown
- Agricultural Representatives Branch
- Plant Industry Branch

Agriculture Canada
- Research Station, Harrow
- Research Station, Ottawa
- Research Station, Kapuskasing
- Research Station, Thunder Bay

Ontario Cereal Crops Committee
Ontario Corn Committee
Ontario Crop Protection Committee
Ontario Field Bean Committee
Ontario Forage Crops Committee
Ontario Oil and Protein Seed Crops Committee
Ontario Soil Management Research Committee
Ontario Weed Committee

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